

# Encyclopedia of Mosaic Art



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First Edition, 2012

ISBN 978-81-323-4792-7

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*Published by:*

**The English Press**

4735/22 Prakashdeep Bldg,

Ansari Road, Darya Ganj,

Delhi - 110002

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# **Table of Contents**

Chapter 1 - Introduction & History of Mosaic Art

Chapter 2 - Late Antique and Medieval Mosaics in Italy

Chapter 3 - Early Byzantine Mosaics in the Middle East

Chapter 4 - Photographic Mosaic and Color Filter Mosaic

Chapter 5 - Components & Applications of Mosaic

## Chapter-1

# Introduction & History of Mosaic Art

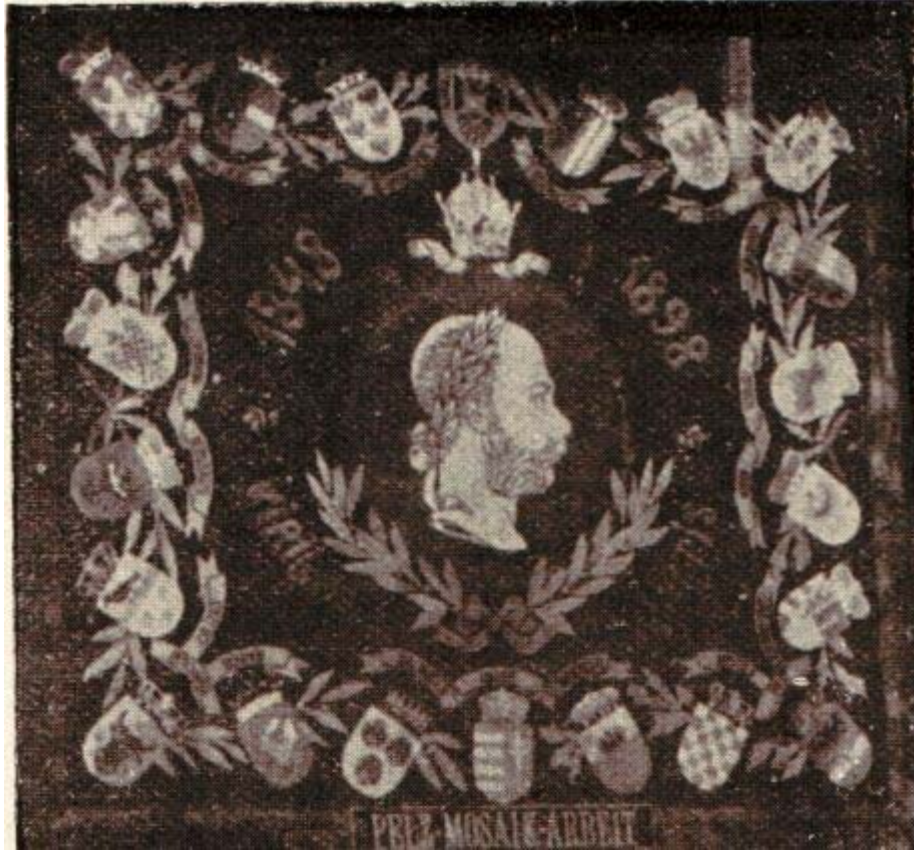


Irano-Roman floor mosaic detail from the palace of Shapur I at Bishapur.





cone mosaic courtyard from Uruk in Mesopotamia 3000 B.C.



Fur mosaic with portrait of Emperor Franz Joseph

**Mosaic** is the art of creating images with an assemblage of small pieces of colored glass, stone, or other materials. It may be a technique of decorative art, an aspect of interior decoration, or of cultural and spiritual significance as in a cathedral. Small pieces, normally roughly cubic, of stone or glass of different colors, known as *tesserae*, (diminutive *tessellae*), are used to create a pattern or picture.



## ***Mosaic terminology***



A mosaic showing opus palladianum (white background on upper right and blue shards in circle, lower right). Opus vermiculatum is demonstrated by the single narrow lines of tiles around the edge of each circle. The red tiles in the small full circle demonstrate opus tessellatum by forming horizontal but not vertical rows.

Mosaic is an art form which uses small pieces of materials placed together to create a unified whole. The materials commonly used are marble or other stone, glass, pottery, mirror or foil-backed glass, or shells.

The term for each piece of material is Tessera (plural: *tesserae*). The term for the spaces in between where the grout goes is the interstices. Andamento is the word used to

describe the movement and flow of Tesserae. The 'opus', the Latin for 'work', is the way in which the pieces are cut and placed varies and is known.

Common techniques include:

- Opus regulatum: A grid; all tesserae align both vertically and horizontally.
- Opus tessellatum: Tesserae form vertical or horizontal rows, but not both.
- Opus vermiculatum: One or more lines of tesserae follow the edge of a special shape (letters or a major central graphic).
- Opus musivum: Vermiculatum extends throughout the entire background.
- Opus palladianum: Instead of forming rows, tesserae are irregularly shaped. Also known as "crazy paving".
- Opus sectile: A major shape (e.g. heart, letter, cat) is formed by a single tessera, as later in pietra dura.
- Opus classicum: When vermiculatum is combined with tessellatum or regulatum.
- Opus circumactum: Tesserae are laid in overlapping semicircles or fan shapes.
- Micromosaic: using very small tesserae, in Byzantine icons and Italian panels for jewellery from the Renaissance on.

### ***Three techniques***

There are three main methods: the direct method, the indirect method and the double indirect method.



## Direct method



A 'Direct Method' mosaic courtyard made from irregular pebbles and stone strips, Li Jiang, Yunnan, PRC (China)

The direct method of mosaic construction involves directly placing (gluing) the individual tesserae onto the supporting surface. This method is well suited to surfaces that have a three-dimensional quality, such as vases. This was used for the historic European wall and ceiling mosaics, following underdrawings of the main outlines on the wall below, which are often revealed again when the mosaic falls away.

The direct method suits small projects that are transportable. Another advantage of the direct method is that the resulting mosaic is progressively visible, allowing for any adjustments to tile colors placement.

The disadvantage of the direct method is that the artist must work directly at the chosen surface, which is often not practical for long periods of time. It is today considered unsuitable for large scale projects. Also, it is difficult to control the evenness of the finished surface. This is of particular importance when creating a functional surface such as a floor or a table top.

A modern version of the direct method, sometimes called "double direct," is to work directly onto fiberglass mesh. The mosaic can then be constructed with the design visible on the surface and transported to its final location. Large work can be done in this way, with the mosaic being cut up for shipping and then reassembled for installation. It enables the artist to work in comfort in a studio rather than at the site of installation.

### **Indirect method**



Assembling a mosaic at the Sagrada Família, Barcelona

The indirect method of applying tesserae is often used for very large projects, projects with repetitive elements or for areas needing site specific shapes. Tiles are applied face-down to a backing paper using an adhesive, and later transferred onto walls, floors or craft projects. This method is most useful for extremely large projects as it gives the

maker time to rework areas. Mosaic murals, benches and tabletops are some of the items usually made using the indirect method, as it results in a smoother and more even surface.

## **Double indirect method**

The double indirect method can be used when it is important to see the work during the creation process as it will appear when completed. The tesserae are placed face-up on a medium (often adhesive-backed paper, sticky plastic or soft lime or putty) as it will appear when installed. When the mosaic is complete, a similar medium is placed atop it. The piece is then turned over, the original underlying material is carefully removed, and the piece is installed as in the indirect method described above. In comparison to the indirect method, this is a complex system to use and requires great skill on the part of the operator, to avoid damaging the work. Its greatest advantage lies in the possibility of the operator directly controlling the final result of the work, which is important e.g. when the human figure is involved.

## ***Mathematics***

The best way to arrange variously shaped tiles on a surface can lead to complicated mathematical problems. Roger Penrose is a British mathematician who has worked with tiling problems.

The artist M. C. Escher was influenced by Moorish mosaics to begin his investigations into tessellation.

The maze designer and artist Adrian Fisher creates modern mosaic using his patented Mitre Mosaic system (co-invented with Ed Pegg), which involves three principal shapes (Pyramid, Fin and Mitre). These shapes combine to form highly vigorous patterns; with the judicious selection of color, they can achieve spirited images, abstract patterns, and so on. Using the Mitre System, an area can be tiled infinitely without fault lines in any direction, yet whenever needed, can 'resolve' to a straight edge, by the use of two additional shapes (Square and Diamond). The position and alignment of every mosaic piece is predetermined to a fraction of a millimetre. The system is scalable by cutting the tesserae by waterjet to any chosen size, so that the final mosaic can fit any given space. This method is much more productive of artistic time without compromising the creative result. A notable example is his 7.2 x 1.22 metre mosaic mural installed in 2010 within the SciTec Building at Oundle School, Northamptonshire, England, which contains 9,104 pieces of mosaic, and uses 20 different colors of glazed ceramic mosaic tiles. There are four of his mosaics using the Mitre System within the Millennium Maze in Higginson Park, Marlow, Buckinghamshire, England (installed 2000). He has also created private commissions using the Mitre Mosaic System.

## ***Digital imaging***

A mosaic in digital imaging is a plurality of non-overlapping images, arranged in some tessellation. A photomosaic is a picture made up of various other pictures (pioneered by Joseph Francis), in which each "pixel" is another picture, when examined closely.

A tile mosaic is a digital image made up of individual tiles, arranged in a non-overlapping fashion, e.g. to make a static image on a shower room or bathing pool floor, by breaking the image down into square pixels formed from ceramic tiles (a typical size is 1 inch by 1 inch, as for example, on the floor of the University of Toronto pool, though sometimes larger tiles such as 2 by 2 inch are used). These digital images are coarse in resolution and often simply express text, such as the depth of the pool in various places, but some such digital images are used to show a sunset or other beach theme.

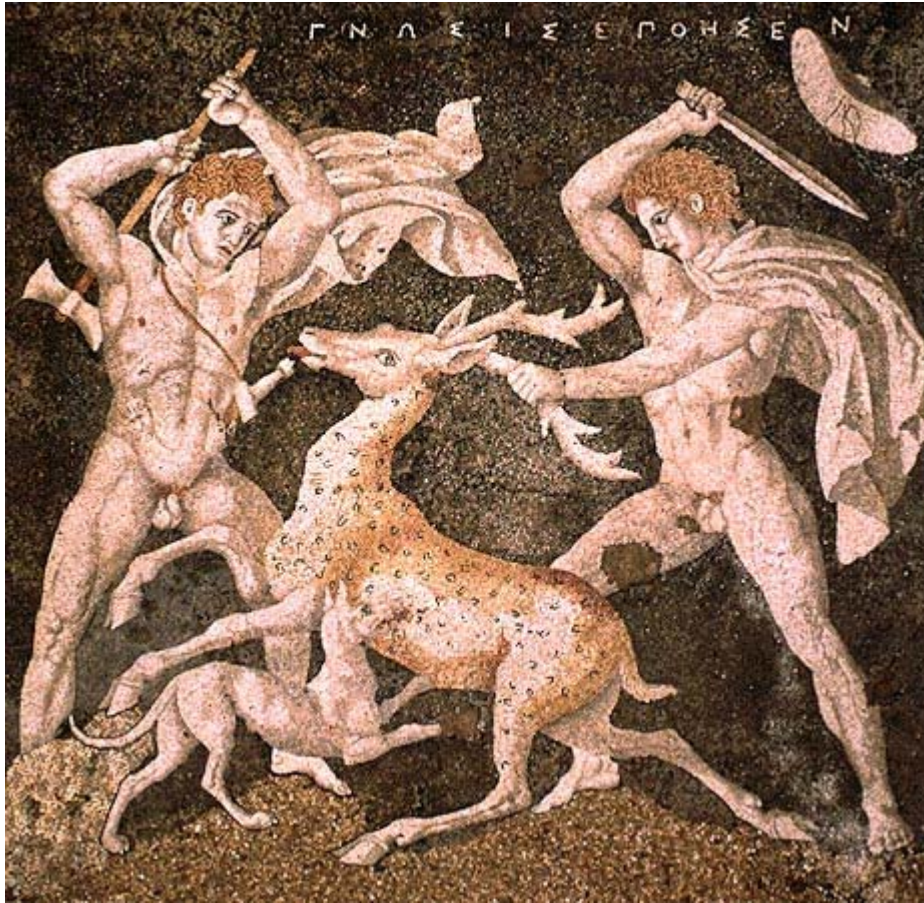
Recent developments in digital image processing have led to the ability to design physical tile mosaics using computer aided design (CAD) software. The software typically takes as inputs a source bitmap and a palette of colored tiles. The software makes a best-fit match of the tiles to the source image.

## ***Robotic manufacturing***

With high cost of labor in developed countries, production automation has become increasingly popular. Rather than being assembled by hand, mosaics designed using computer aided design (CAD) software can be assembled by robot. Production can be greater than 10 times faster with higher accuracy. But these "computer" mosaics have a different look than hand-made "artisanal" mosaics. With robotic production, colored tiles are loaded into buffers, and then the robot picks and places tiles individually according to a command file from the design software.



## ***History of the Mosaic***



Ancient Greek mosaic, a deer hunt, detail from the mosaic floor, signed "Gnosis created" ("ΓΝΩΣΙΣ ΕΠΟΗΣΕΝ") in the *House of the Abduction of Helen* at Pella, late 4th century BC, Pella Archaeological Museum.





Roman mosaic of Ulysses, from Carthage. Now in the Bardo Museum, Tunisia



*Cave canem* mosaics ('Beware of the dog') were a popular motif for the thresholds of Roman villas





A small part of *The Great Pavement*, a Roman mosaic laid in AD 325 at Woodchester, Gloucestershire, England.

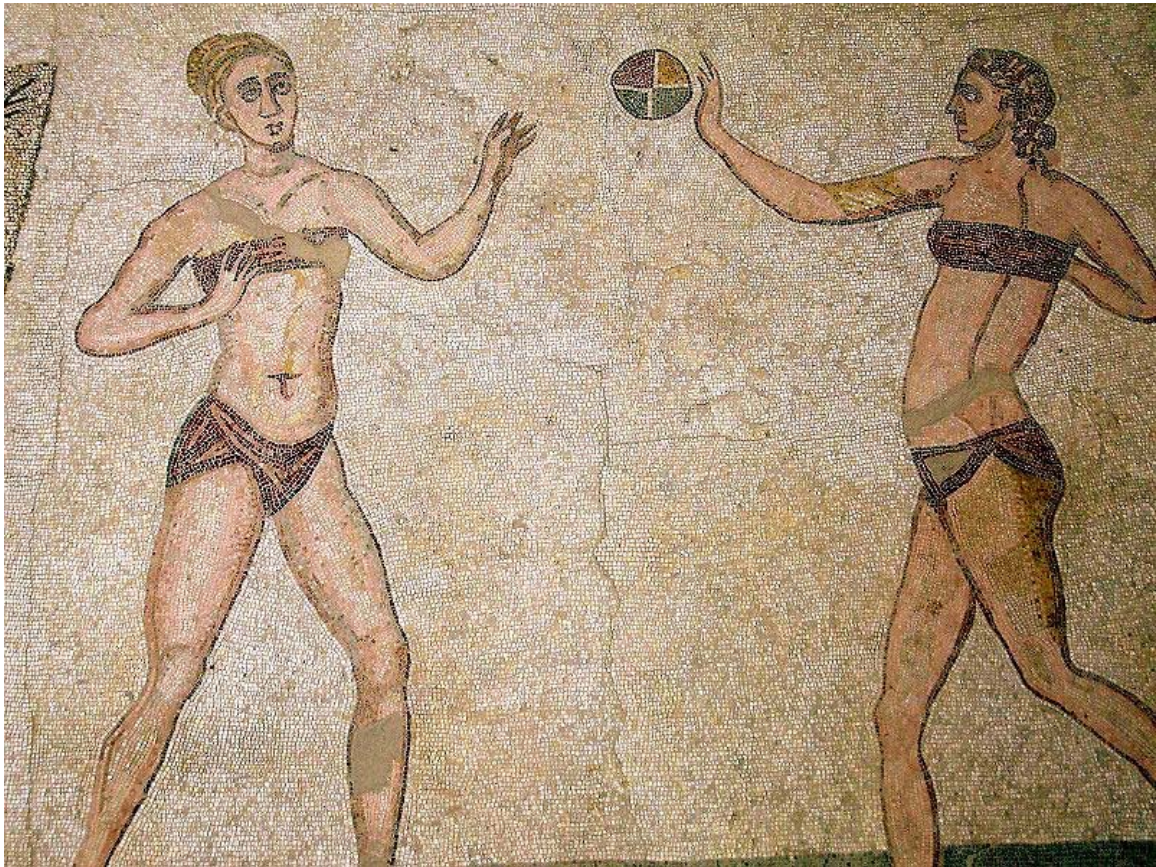
The earliest known examples of mosaics made of different materials were found at a temple building in Ubaid, Mesopotamia, and are dated to the second half of 3rd millennium BC. They consist of pieces of colored stones, shells and ivory. Excavations at Susa and Choqa Zanbil show evidence of the first glazed tiles, dating from around 1500 BC. However, mosaic patterns were not used until the times of Sassanid Empire and Roman influence.

Mosaics of the 4th century BC are found in the Macedonian palace-city of Aegae and they enriched the floors of Hellenistic villas, and Roman dwellings from Britain to Dura-Europos. Splendid mosaic floors are found in Roman villas across north Africa, in places such as Carthage, and can still be seen in the extensive collection in Bardo Museum in Tunis, Tunisia. In Rome, Nero and his architects used mosaics to cover the surfaces of walls and ceilings in the *Domus Aurea*, built AD 64.

The mosaics of the Villa Romana del Casale near Piazza Armerina in Sicily are the largest collection of late Roman mosaics *in situ* in the world, and are protected as a UNESCO World Heritage Site. The large *villa rustica*, which was probably owned by Emperor Maximian, was built largely in the early 4th century. The mosaics were covered and protected for 700 years by a landslide that occurred in the 12th century. The most



important pieces are the *Circus Scene*, the 64 m long *Great Hunting Scene*, the *Little Hunt*, the *Labours of Hercules* and the famous *Bikini Girls*, showing women exercising in modern-looking bikinis. The peristyle, the imperial apartments and the *thermae* were also decorated with ornamental and mythological mosaics. Other important examples of Roman mosaic art in Sicily were unearthed on the Piazza Vittoria in Palermo where two houses were discovered. The most important scenes there depicted *Orpheus*, *Alexander the Great's Hunt* and the *Four Seasons*.



Mosaics of girls in bikinis at the Villa Romana

In 2000 archaeologists working in Leptis Magna, Libya uncovered a 30 ft length of five colorful mosaics created during the 1st or 2nd century. The mosaics show a warrior in combat with a deer, four young men wrestling a wild bull to the ground, and a gladiator resting in a state of fatigue, staring at his slain opponent. The mosaics decorated the walls of a cold plunge pool in a bath house within a Roman villa. The gladiator mosaic is noted by scholars as one of the finest examples of mosaic art ever seen — a "masterpiece comparable in quality with the Alexander Mosaic in Pompeii."



## **Christian mosaic**

### **Early Christian art**

With the building of Christian basilicas in the late 4th century, wall and ceiling mosaics were adopted for Christian uses. The earliest examples of Christian basilicas have not survived, but the mosaics of Santa Constanza and Santa Pudenziana, both from the 4th century, still exist. The winemaking putti in the ambulatory of Santa Constanza still follow the classical tradition in that they represent the feast of Bacchus, which symbolizes transformation or change, and are thus appropriate for a mausoleum, the original function of this building. In another great Constantinian basilica, the Church of the Nativity in Bethlehem the original mosaic floor with typical Roman geometric motifs is partially preserved. The so-called Tomb of the Julii, near the crypt beneath St Peter's Basilica, is a 4th-century vaulted tomb with wall and ceiling mosaics that are given Christian interpretations. The former Tomb of Galerius in Thessaloniki, converted into a Christian church during the course of the 4th century, was embellished with very high artistic quality mosaics. Only fragments survive of the original decoration, especially a band depicting saints with hands raised in prayer, in front of complex architectural fantasies.

In the following century Ravenna, the capital of the Western Roman Empire, became the center of late Roman mosaic art. Milan also served as the capital of the western empire in the 4th century. In the St Aquilinus Chapel of the Basilica of San Lorenzo, mosaics executed in the late 4th and early 5th centuries depict Christ with the Apostles and the Abduction of Elijah; these mosaics are outstanding for their bright colors, naturalism and adherence to the classical canons of order and proportion. The surviving apse mosaic of the Basilica of Sant'Ambrogio, which shows Christ enthroned between Saint Gervasius and Saint Protasius and angels before a golden background date back to the 5th and to the 8th century, although it was restored many times later. The baptistery of the basilica, which was demolished in the 15th century, had a vault covered with gold-leaf tesserae, large quantities of which were found when the site was excavated. In the small shrine of San Vittore in ciel d'oro, now a chapel of Sant'Ambrogio, every surface is covered with mosaics from the second half of the 5th century. Saint Victor is depicted in the center of the golden dome, while figures of saints are shown on the walls before a blue background. The low spandrels give space for the symbols of the four.

Albingaunum was the main Roman port of Liguria. The octagonal baptistery of the town was decorated in the 5th century with high quality blue and white mosaics representing the Apostles. The surviving remains are fragmentary.

A mosaic pavement depicting humans, animals and plants from the original 4th-century cathedral of Aquileia has survived in the later medieval church. This mosaic adopts pagan motifs such as the Nilotic scene, but behind the traditional naturalistic content is Christian symbolism such as the ichthys. The 6th-century early Christian basilicas of Sant'Eufemia it: Basilica di Sant'Eufemia (Grado) and Santa Maria delle Grazie in Grado also have mosaic floors.

## **Ravenna**

In the 5th century Ravenna, the capital of the Western Roman Empire, became the center of late Roman mosaic art. The Mausoleum of Galla Placidia was decorated with mosaics of high artistic quality in 425-430. The vaults of the small, cross-shaped structure are clad with mosaics on blue background. The central motif above the crossing is a golden cross in the middle of the starry sky. Another great building established by Galla Placidia was the Church of San Giovanni Evangelista. She erected it in fulfillment of a vow that she made having escaped from a deadly storm in 425 on the sea voyage from Constantinople to Ravenna. The mosaics depicted the storm, portraits of members of the western and eastern imperial family and the bishop of Ravenna, Peter Chrysologus. They are only known from Renaissance sources because they were destroyed in 1569.

Ostrogoths kept alive the tradition in the 6th century, as the mosaics of the Arian Baptistery, Baptistery of Neon, Archiepiscopal Chapel, and the earlier phase mosaics in the Basilica of San Vitale and Basilica of Sant'Apollinare Nuovo testify.

After 539 Ravenna was conquered by the Byzantine Empire and became the seat of the Exarchate of Ravenna. The greatest development of Christian mosaics unfolded in the second half of the 6th century. Outstanding examples of Byzantine mosaic art are the later phase mosaics in the Basilica of San Vitale and Basilica of Sant'Apollinare Nuovo. The mosaic depicting Emperor Justinian I and Empress Theodora in the Basilica of San Vitale were executed shortly after the Byzantine conquest. The mosaics of the Basilica of Sant'Apollinare in Classe were made around 549. The anti-Arian theme is obvious in the apse mosaic of San Michele in Affricisco, executed in 545-547 (largely destroyed, the remains in Berlin).

The last example of Byzantine mosaics in Ravenna was commissioned by bishop Reparatus between 673-79 in the Basilica of Sant'Apollinare in Classe. The mosaic panel in the apse showing the bishop with Emperor Constantine IV is obviously an imitation of the Justinian panel in San Vitale.

## **Butrint**

The mosaic pavement of the Vrina Plain basilica of Butrint, Albania appear to pre-date that of the Baptistry by almost a generation, dating to the last quarter of the 5th or the first years of the 6th century AD. The mosaic displays a variety of motifs including sea-creatures, birds, terrestrial beasts, fruits, flowers, trees and abstracts – designed to depict a terrestrial paradise of God's creation. Superimposed on this scheme are two large tablets, tabulae ansatae, carrying inscriptions. A variety of fish, a crab, a lobster, shrimps, mushrooms, flowers, a stag and two cruciform designs surround the smaller of the two inscriptions, which reads: In fulfilment of the vow (prayer) of those whose names God knows. This anonymous dedicatory inscription is a public demonstration of the benefactors' humility and an acknowledgement of God's omniscience.

The abundant variety of natural life depicted in the Butrint mosaics celebrates the richness of God's creation; some elements also have specific connotations. The kantharos vase and vine refer to the eucharist, the symbol of the sacrifice of Christ leading to salvation. Peacocks are symbols of paradise and resurrection; shown eating or drinking from the vase they indicate the route to eternal life. Deer or stags were commonly used as images of the faithful aspiring to Christ: 'like a hart desires the water brook, so my souls longs for thee, O God.' Water-birds and fish and other sea-creatures can indicate baptism as well as the members of the Church who are christened.

Butrint is a UNESCO World Heritage Site.

## **Late Antique and Early Medieval Rome**

Christian mosaic art also flourished in Rome, gradually declining as conditions became more difficult in the Early Middle Ages. Fifth-century mosaics can be found over the triumphal arch and in the nave of the basilica of Santa Maria Maggiore. The 27 surviving panels of the nave are the most important mosaic cycle in Rome of this period. Two other important 5th-century mosaics are lost but we know them from 17th-century drawings. In the apse mosaic of Sant'Agata dei Goti (462-472, destroyed in 1589) Christ was seated on a globe with the twelve Apostles flanking him, six on either side. At Sant'Andrea in Catabarbara (468-483, destroyed in 1686) Christ appeared in the center, flanked on either side by three Apostles. Four streams flowed from the little mountain supporting Christ. The original 5th-century apse mosaic of the Santa Sabina was replaced by a very similar fresco by Taddeo Zuccari in 1559. The composition probably remained unchanged: Christ flanked by male and female saints, seated on a hill while lambs drinking from a stream at its feet. All three mosaics had a similar iconography.

6th-century pieces are rare in Rome but the mosaics inside the triumphal arch of the basilica of San Lorenzo fuori le mura belong to this era. The *Chapel of Ss. Primo e Feliciano* in Santo Stefano Rotondo has very interesting and rare mosaics from the 7th century. This chapel was built by Pope Theodore I as a family burial place.

In the 7-9th centuries Rome fell under the influence of Byzantine art, noticeable on the mosaics of Santa Prassede, Santa Maria in Domnica, Sant'Agnese fuori le Mura, Santa Cecilia in Trastevere, Santi Nereo e Achilleo and the San Venanzio chapel of San Giovanni in Laterano. The great dining hall of Pope Leo III in the Lateran Palace was also decorated with mosaics. They were all destroyed later except for one example, the so-called Triclinio Leoniano of which a copy was made in the 18th century. Another great work of Pope Leo, the apse mosaic of Santa Susanna, depicted Christ with the Pope and Charlemagne on one side, and Ss. Susanna and Felicity on the other. It was plastered over during a renovation in 1585. Pope Paschal I (817-824) embellished the church of Santo Stefano del Cacco with an apsidal mosaic which depicted the pope with a model of the church (destroyed in 1607).

The fragment of an 8th-century mosaic, the Epiphany is one of the very rare remaining pieces of the medieval decoration of Old St. Peter's Basilica, demolished in the late 16th

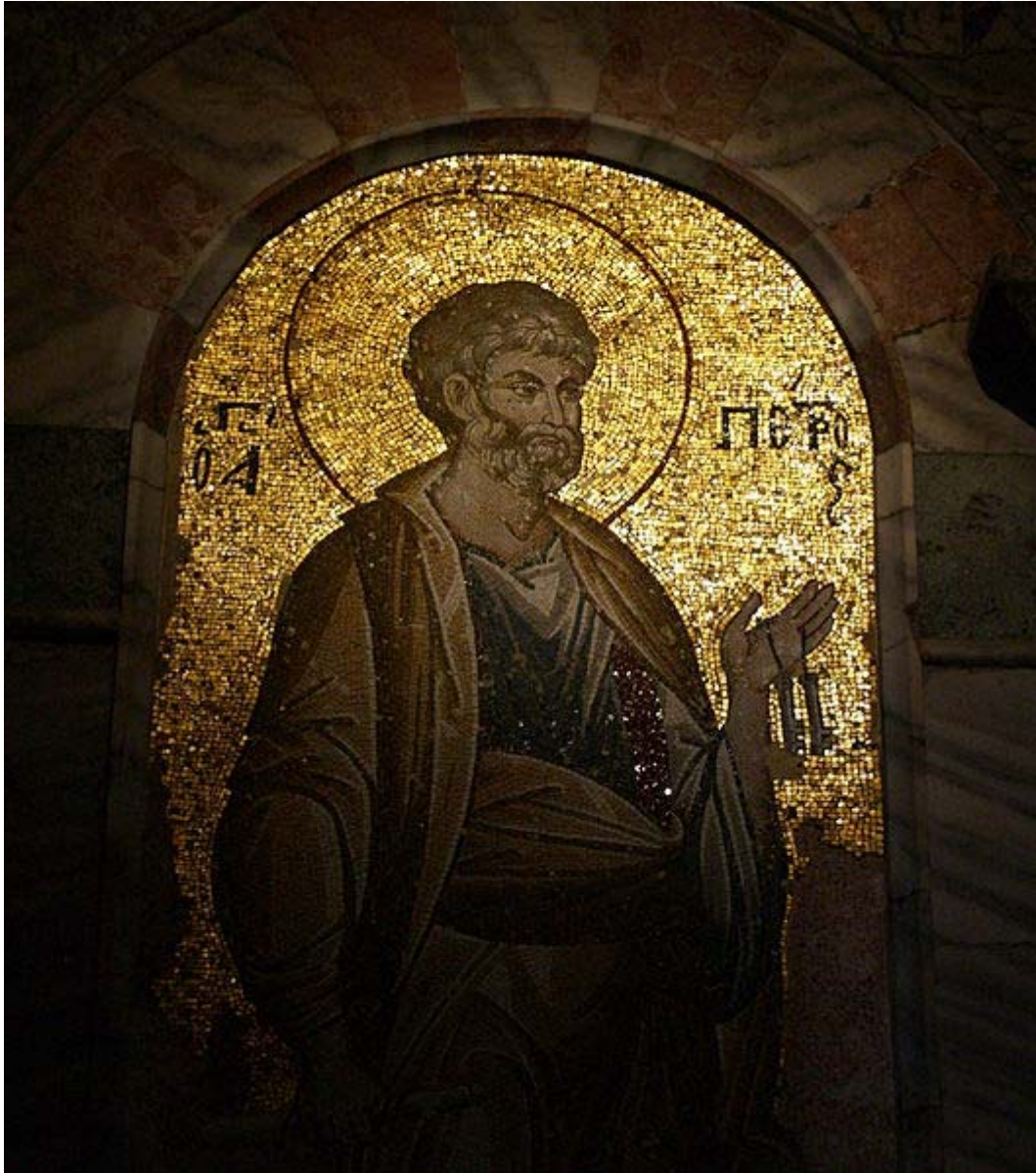
century. The precious fragment is kept in the sacristy of Santa Maria in Cosmedin. It proves the high artistic quality of the destroyed St. Peter's mosaics.

### **Byzantine mosaics**



The so-called Gothic chieftain, from the Mosaic Peristyle of the Great Palace of Constantinople





Saint Peter mosaic from the Chora Church

Mosaics were more central to Byzantine culture than to that of Western Europe. Byzantine church interiors were generally covered with golden mosaics. Mosaic art flourished in the Byzantine Empire from the 6th to the 15th century. The majority of Byzantine mosaics were destroyed without trace during wars and conquests, but the surviving remains still form a fine collection.

The great buildings of Emperor Justinian like the Hagia Sophia in Constantinople, the Nea Church in Jerusalem and the rebuilt Church of the Nativity in Bethlehem were certainly embellished with mosaics but none of these survived.

Important fragments survived from the mosaic floor of the Great Palace of Constantinople which was commissioned during Justinian's reign. The figures, animals, plants all are entirely classical but they are scattered before a plain background. The portrait of a moustached man, probably a Gothic chieftain, is considered the most important surviving mosaic of the Justinianian age. The so-called *small sekreton* of the palace was built during Justin II's reign around 565-577. Some fragments survive from the mosaics of this vaulted room. The vine scroll motifs are very similar to those in the Santa Constanza and they still closely follow the Classical tradition. There are remains of floral decoration in the Church of the Acheiropoietos in Thessaloniki (5th-6th centuries).



A pre-Iconoclastic depiction of St. Demetrios at the Hagios Demetrios Basilica in Thessaloniki.

In the 6th century, Ravenna, the capital of Byzantine Italy, became the center of mosaic making. Istria also boasts some important examples from this era. The Euphrasian Basilica in Parenium was built in the middle of the 6th century and decorated with mosaics depicting the Theotokos flanked by angels and saints.

Fragments remain from the mosaics of the Church of Santa Maria Formosa in Pola. These pieces were made during the 6th century by artists from Constantinople. Their pure Byzantine style is different from the contemporary Ravennate mosaics.

Very few early Byzantine mosaics survived the Iconoclastic destruction of the 8th century. Among the rare examples are the 6th-century *Christ in majesty* (or *Ezekiel's Vision*) mosaic in the apse of the Osios David Church in Thessaloniki that was hidden behind mortar during those dangerous times. The mosaics of the Hagios Demetrios Church, which were made between 634 and 730, also escaped destruction. Unusually almost all represent Saint Demetrius of Thessaloniki, often with suppliants before him.

In the Iconoclastic era, figural mosaics were also condemned as idolatry. The Iconoclastic churches were embellished with plain gold mosaics with only one great cross in the apse like the Hagia Irene in Constantinople (after 740). There were similar crosses in the apses of the Hagia Sophia Church in Thessaloniki and in the Church of the Dormition in Nicaea. The crosses were substituted with the image of the Theotokos in both churches after the victory of the Iconodules (787-797 and in 8-9th centuries respectively, the Dormition church was totally destroyed in 1922).

A similar Theotokos image flanked by two archangels were made for the Hagia Sophia in Constantinople in 867. The dedication inscription says: "The images which the impostors had cast down here pious emperors have again set up." In the 870s the so-called *large sekreton* of the Great Palace of Constantinople was decorated with the images of the four great iconodule patriarchs.

The post-Iconoclastic era was the heyday of Byzantine art with the most beautiful mosaics executed. The mosaics of the Macedonian Renaissance (867-1056) carefully mingled traditionalism with innovation. Constantinopolitan mosaics of this age followed the decoration scheme first used in Emperor Basil I's Nea Ekklesia. Not only this prototype was later totally destroyed but each surviving composition is battered so it is necessary to move from church to church to reconstruct the system.

An interesting set of Macedonian-era mosaics make up the decoration of the Hosios Loukas Monastery. In the narthex there is the Crucifixion, the Pantokrator and the Anastasis above the doors, while in the church the Theotokos (apse), Pentecost, scenes from Christ's life and ermit St Loukas (all executed before 1048). The scenes are treated with a minimum of detail and the panels are dominated with the gold setting.





Detail of mosaic from Nea Moni Monastery

The Nea Moni Monastery on Chios was established by Constantine Monomachos in 1043-1056. The exceptional mosaic decoration of the dome showing probably the nine orders of the angels was destroyed in 1822 but other panels survived (Theotokos with raised hands, four evangelists with seraphim, scenes from Christ's life and an interesting Anastasis where King Salomon bears resemblance to Constantine Monomachos). In comparison with Osios Loukas Nea Moni mosaics contain more figures, detail, landscape and setting.

Another great undertaking by Constantine Monomachos was the restoration of the Church of the Holy Sepulchre in Jerusalem between 1042 and 1048. Nothing survived of the mosaics which covered the walls and the dome of the edifice but the Russian abbot



Daniel, who visited Jerusalem in 1106-1107 left a description: "Lively mosaics of the holy prophets are under the ceiling, over the tribune. The altar is surmounted by a mosaic image of Christ. In the main altar one can see the mosaic of the Exhaltation of Adam. In the apse the Ascension of Christ. The Annunciation occupies the two pillars next to the altar."

The Daphni Monastery houses the best preserved complex of mosaics from the early Comnenan period (ca. 1100) when the austere and hieratic manner typical for the Macedonian epoch and represented by the awesome Christ Pantocrator image inside the dome, was metamorphosing into a more intimate and delicate style, of which *The Angel before St Joachim* — with its pastoral backdrop, harmonious gestures and pensive lyricism — is considered a superb example.

The 9th and 10th-century mosaics of the Hagia Sophia in Constantinople are truly classical Byzantine artworks. The north and south tympana beneath the dome was decorated with figures of prophets, saints and patriarchs. Above the principal door from the narthex we can see an *Emperor kneeling before Christ* (late 9th or early 10th century). Above the door from the southwest vestibule to the narthex another mosaic shows the *Theotokos with Justinian and Constantine*. Justinian I is offering the model of the church to Mary while Constantine is holding a model of the city in his hand. Both emperors are beardless - this is an example for conscious archaization as contemporary Byzantine rulers were bearded. A mosaic panel on the gallery shows *Christ with Constantine Monomachos and Empress Zoe* (1042–1055). The emperor gives a bulging money sack to Christ as a donation for the church.

The dome of the Hagia Sophia Church in Thessaloniki is decorated with an *Ascension* mosaic (c. 885). The composition resembles the great baptistries in Ravenna, with apostles standing between palms and Christ in the middle. The scheme is somewhat unusual as the standard post-Iconoclastic formula for domes contained only the image of the Pantokrator.



Mosaic of Christ Pantocrator from Hagia Sophia from the *Deesis* mosaic.

There are very few existing mosaics from the Komnenian period but this paucity must be due to accidents of survival and gives a misleading impression. The only surviving 12th-century mosaic work in Constantinople is a panel in Hagia Sophia depicting Emperor John II and Empress Eirene with the Theotokos (1122–34). The empress with her long braided hair and rosy cheeks is especially capturing. It must be a life-like portrayal because Eirene was really a redhead as her original Hungarian name, *Piroska* shows. The adjacent portrait of Emperor Alexios I Komnenos on a pier (from 1122) is similarly personal. The imperial mausoleum of the Komnenos dynasty, the Pantokrator Monastery was certainly decorated with great mosaics but these were later destroyed. The lack of Komnenian mosaics outside the capital is even more apparent. There is only a "Communion of the Apostles" in the apse of the cathedral of Serres.

A striking technical innovation of the Komnenian period was the production of very precious, miniature mosaic icons. In these icons the small tesserae (with sides of 1 mm or less) were set on wax or resin on a wooden panel. These products of extraordinary craftsmanship were intended for private devotion. The Louvre Transfiguration is a very fine example from the late 12th century. The miniature mosaic of Christ in the Museo Nazionale at Florence illustrates the more gentle, humanistic conception of Christ which appeared in the 12th century.

The sack of Constantinople in 1204 caused the decline of mosaic art for the next five decades. After the reconquest of the city by Michael VIII Palaiologos in 1261 the Hagia Sophia was restored and a beautiful new *Deesis* was made on the south gallery. This huge mosaic panel with figures two and a half times lifesize is really overwhelming due to its grand scale and superlative craftsmanship. The Hagia Sophia *Deesis* is probably the most famous Byzantine mosaic in Constantinople.

The Pammakaristos Monastery was restored by Michael Glabas, an imperial official, in the late 13th century. Only the mosaic decoration of the small burial chapel (parekklesion) of Glabas survived. This domed chapel was built by his widow, Martha around 1304-08. In the miniature dome the traditional Pantokrator can be seen with twelve prophets beneath. Unusually the apse is decorated with a *Deesis*, probably due to the funerary function of the chapel.

The Church of the Holy Apostles in Thessaloniki was built in 1310-14. Although some vandal systematically removed the gold tesserae of the background it can be seen that the Pantokrator and the prophets in the dome follow the traditional Byzantine pattern. Many details are similar to the Pammakaristos mosaics so it is supposed that the same team of mosaicists worked in both buildings. Another building with a related mosaic decoration is the Theotokos Paregoritissa Church in Arta. The church was established by the Despot of Epirus in 1294-96. In the dome is the traditional stern Pantokrator, with prophets and cherubim below.



Mosaic of Theodore Metochites offering the Chora Church to Christ

The greatest mosaic work of the Palaeologan renaissance in art is the decoration of the Chora Church in Constantinople. Although the mosaics of the naos have not survived except three panels, the decoration of the exonarthex and the esonarthex constitute the most important full-scale mosaic cycle in Constantinople after the Hagia Sophia. They were executed around 1320 by the command of Theodore Metochites. The esonarthex has two fluted domes, specially created to provide the ideal setting for the mosaic images of the ancestors of Christ. The southern one is called the Dome of the Pantokrator while the northern one is the Dome of the Theotokos. The most important panel of the esonarthex depicts Theodore Metochites wearing a huge turban, offering the model of the church to Christ. The walls of both narthexes are decorated with mosaic cycles from the life of the Virgin and the life of Christ. These panels show the influence of the Italian trecento on Byzantine art especially the more natural settings, landscapes, figures.

The last Byzantine mosaic work was created for the Hagia Sophia, Constantinople in the middle of the 14th century. The great eastern arch of the cathedral collapsed in 1346, bringing down the third of the main dome. By 1355 not only the big Pantokrator image was restored but new mosaics were set on the eastern arch depicting the Theotokos, the Baptist and Emperor John V Palaiologos (discovered only in 1989).



In addition to the large-scale monuments several miniature mosaic icons of outstanding quality was produced for the Palaiologos court and nobles. The loveliest examples from the 14th century are *Annunciation* in the Victoria and Albert Museum and a mosaic diptych in the Cathedral Treasury of Florence representing the *Twelve Feasts of the Church*.

In the troubled years of the 15th century the fatally weakened empire could not afford luxurious mosaics. Churches were decorated with wall-paintings in this era and after the Turkish conquest.

## Rome in the High Middle Ages



Apse mosaic in the Santa Maria Maggiore

The last great period of Roman mosaic art was the 12-13th century when Rome developed its own distinctive artistic style, free from the strict rules of eastern tradition and with a more realistic portrayal of figures in the space. Well-known works of this period are the floral mosaics of the Basilica di San Clemente, the façade of Santa Maria in Trastevere and San Paolo fuori le Mura. The beautiful apse mosaic of Santa Maria in Trastevere (1140) depicts Christ and Mary sitting next to each other on the heavenly throne, the first example of this iconographic scheme. A similar mosaic, the Coronation of the Virgin, decorates the apse of Santa Maria Maggiore. It is a work of Jacopo Torriti from 1295. The mosaics of Torriti and Jacopo da Camerino in the apse of San Giovanni in Laterano from 1288-94 were thoroughly restored in 1884. The apse mosaic of San

Crisogono is attributed to Pietro Cavallini, the greatest Roman painter of the 13th century. Six scenes from the life of Mary in Santa Maria in Trastevere were also executed by Cavallini in 1290. These mosaics are praised for their realistic portrayal and attempts of perspective. There is an interesting mosaic medaillon from 1210 above the gate of the church of San Tommaso in Formis showing Christ enthroned between a white and a black slave. The church belonged to the Order of the Trinitarians which was devoted to ransoming Christian slaves.

The great Navicella mosaic (1305–1313) in the atrium of the Old St. Peter's is attributed to Giotto di Bondone. The giant mosaic, commissioned by Cardinal Jacopo Stefaneschi, was originally situated on the eastern porch of the old basilica and occupied the whole wall above the entrance arcade facing the courtyard. It depicted St. Peter walking on the waters. This extraordinary work was mainly destroyed during the construction of the new St. Peter's in the 17th century. Navicella means "little ship" referring to the large boat which dominated the scene, and whose sail, filled by the storm, loomed over the horizon. Such a natural representation of a seascape was known only from ancient works of art.

## **Sicily**

The heyday of mosaic making in Sicily was the age of the independent Norman kingdom in the 12th century. The Norman kings adopted the Byzantine tradition of mosaic decoration to enhance the somewhat dubious legality of their rule. Greek masters working in Sicily developed their own style, that shows the influence of Western European and Islamic artistic tendencies. Best examples of Sicilian mosaic art are the Cappella Palatina of Roger II, the Martorana church in Palermo and the cathedrals of Cefalù and Monreale.

The Cappella Palatina clearly shows evidence for blending the eastern and western styles. The dome (1142–42) and the eastern end of the church (1143–1154) were decorated with typical Byzantine mosaics i.e. Pantokrator, angels, scenes from the life of Christ. Even the inscriptions are written in Greek. The narrative scenes of the nave (Old Testament, life of Sts Peter and Paul) are resembling to the mosaics of the Old St. Peter's and St. Paul's Basilica in Rome (Latin inscriptions, 1154–66).

The Martorana church (decorated around 1143) looked originally even more Byzantine although important parts were later demolished. The dome mosaic is very similar to that of the Cappella Palatina with Christ enthroned in the middle and four bowed, elongated angels. The Greek inscriptions, decorative patterns, the evangelists in the squinches are obviously executed by the same Greek masters who worked on Cappella Palatina. The mosaic depicting Roger II of Sicily, dressed in Byzantine imperial robes, receiving the crown by Christ was originally in the demolished narthex together with another panel, the Theotokos with Georgios of Antiochia, the founder of the church.

In Cefalù (1148) only the high, French Gothic presbytery was covered with mosaics: the Pantokrator on the semidome of the apse and cherubim on the vault. On the walls we can see Latin and Greek saints, with Greek inscriptions.

The Monreale mosaics constitute the largest decoration of this kind in Italy, covering 0,75 hectares with at least 100 million glass and stone tesserae. This huge work was executed between 1176 and 1186 by the order of King William II of Sicily. The iconography of the mosaics in the presbytery is similar to Cefalu while the pictures in the nave are almost the same as the narrative scenes in the Cappella Palatina. The Martorana mosaic of Roger II blessed by Christ was repeated with the figure of King William II instead of his predecessor. Another panel shows the king offering the model of the cathedral to the Theotokos.

The Cathedral of Palermo, rebuilt by Archbishop Walter in the same time (1172–85), was also decorated with mosaics but none of these survived except the 12th-century image of *Madonna del Tocco* above the western portal.

The cathedral of Messina, consecrated in 1197, was also decorated with a great mosaic cycle, originally on par with Cefalù and Monreale, but heavily damaged and restored many times later. In the left apse of the same cathedral 14th-century mosaics survived, representing the Madonna and Child between Saints Agata and Lucy, the Archangels Gabriel and Michael and Queens Eleonora and Elisabetta.

Southern Italy was also part of the Norman kingdom but great mosaics did not survive in this area except the fine mosaic pavement of the Otranto cathedral from 1166, with mosaics tied into a tree of life, mostly still preserved. The scenes depict biblical characters, warrior kings, medieval beasts, allegories of the months and working activity. Only fragments survived from the original mosaic decoration of Amalfi's Norman Cathedral. The mosaic ambos in the churches of Ravello prove that mosaic art was widespread in Southern Italy during the 11-13th centuries.

The palaces of the Norman kings were decorated with mosaics depicting animals and landscapes. The secular mosaics are seemingly more Eastern in character than the great religious cycles and show a strong Persian influence. The most notable examples are the *Sala di Ruggero* in the Palazzo dei Normanni, Palermo and the *Sala della Fontana* in the Zisa summer palace, both from the 12th century.



## Venice



Florence Baptistry

In parts of Italy, which were under eastern artistic influences, like Sicily and Venice, mosaic making never went out of fashion in the Middle Ages. The whole interior of the St Mark's Basilica in Venice is clad with elaborate, golden mosaics. The oldest scenes were executed by Greek masters in the late 11th century but the majority of the mosaics are works of local artists from the 12-13th centuries. The decoration of the church was finished only in the 16th century. One hundred and ten scenes of mosaics in the atrium of St Mark's were based directly on the miniatures of the Cotton Genesis, a Byzantine manuscript that was brought to Venice after the sack of Constantinople (1204). The mosaics were executed in the 1220s.

Other important Venetian mosaics can be found in the Cathedral of Santa Maria Assunta in Torcello from the 12th century, and in the Basilical of Santi Maria e Donato in Murano with a restored apse mosaic from the 12th century and a beautiful mosaic pavement (1140). The apse of the San Cipriano Church in Murano was decorated with an impressive golden mosaic from the early 13th century showing Christ enthroned with Mary, St John and the two patron saints, Cipriano and Cipriana. When the church was demolished in the 19th century, the mosaic was bought by Frederick William IV of Prussia. It was reassembled in the Friedenskirche of Potsdam in the 1840s.

Trieste was also an important center of mosaic art. The mosaics in the apse of the Cathedral of San Giusto were laid by master craftsmen from Veneto in the 12-13th centuries.

## **Medieval Italy**

The monastery of Grottaferrata founded by Greek Basilian monks and consecrated by the Pope in 1024 was decorated with Italo-Byzantine mosaics, some of which survived in the narthex and the interior. The mosaics on the triumphal arch portray the Twelve Apostles sitting beside an empty throne, evoking Christ's ascent to Heaven. It is a Byzantine work of the 12th century. There is a beautiful 11th-century Deesis above the main portal.

The Abbot of Monte Cassino, Desiderius sent envoys to Constantinople some time after 1066 to hire expert Byzantine mosaicists for the decoration of the rebuilt abbey church. According to chronicler Leo of Ostia the Greek artists decorated the apse, the arch and the vestibule of the basilica. Their work was admired by contemporaries but was totally destroyed in later centuries except two fragments depicting greyhounds (now in the Monte Cassino Museum). "The abbot in his wisdom decided that great number of young monks in the monastery should be thoroughly initiated in these arts" - says the chronicler about the role of the Greeks in the revival of mosaic art in medieval Italy.

In Florence a magnificent mosaic of the Last Judgement decorates the dome of the Battistero. The earliest mosaics, works of art of many unknown Venetian craftsmen (including probably Cimabue), date from 1225. The covering of the ceiling was probably not completed until the 14th century.

The impressive mosaic of Christ in Majesty, flanked by the Blessed Virgin and St. John the Evangelist in the apse of the cathedral of Pisa was designed by Cimabue in 1302. It evokes the Monreale mosaics in style. It survived the great fire of 1595 which destroyed most of the medieval interior decoration.

Sometimes not only church interiors but façades were also decorated with mosaics in Italy like in the case of the St Mark's Basilica in Venice (mainly from the 17-19th centuries, but the oldest one from 1270–75, "The burial of St Mark in the first basilica"), the Cathedral of Orvieto (golden Gothic mosaics from the 14th century, many times redone) and the Basilica di San Frediano in Lucca (huge, striking golden mosaic representing the Ascension of Christ with the apostles below, designed by Berlinghiero



Berlinghieri in the 13th century). The Cathedral of Spoleto is also decorated on the upper façade with a huge mosaic portraying the *Blessing Christ* (signed by one Solsternus from 1207).

## Western and Central Europe



Carolingian mosaic in Germigny-des-Prés

Beyond the Alps the first important example of mosaic art was the decoration of the Palatine Chapel in Aachen, commissioned by Charlemagne. It was completely destroyed in a fire in 1650. A rare example of surviving Carolingian mosaics is the apse semi-dome decoration of the oratory of Germigny-des-Prés built in 805-806 by Theodulf, bishop of Orléans, a leading figure of the Carolingian renaissance. This unique work of art, rediscovered only in the 19th century, had no followers.

Only scant remains prove that mosaics were still used in the Early Middle Ages. The Abbey of Saint-Martial in Limoges, originally an important place of pilgrimage, was totally demolished during the French Revolution except its crypt which was rediscovered in the 1960s. A mosaic panel was unearthed which was dated to the 9th century. It uses somewhat incongruously cubes of gilded glass and deep green marble, probably taken



from antique pavements. This could also be the case with the early 9th century mosaic found under the cathedral of Saint-Quentin, where antique motifs are copied but using only simple colors. The mosaics in the Cathedral of Saint-Jean at Lyon have been dated to the 11th century because they employ the same non-antique simple colors. More fragments were found on the site of Saint-Croix at Poitiers which might be from the 6th or 9th century.



Close up of the bottom left corner of the picture above.

Later fresco replaced the more labor-intensive technique of mosaic in Western-Europe, although mosaics were sometimes used as decoration on medieval cathedrals. The Royal Basilica of the Hungarian kings in Székesfehérvár (Alba Regia) had a mosaic decoration in the apse. It was probably a work of Venetian or Ravennese craftsmen, executed in the first decades of the 11th century. The mosaic was almost totally destroyed together with the basilica in the 17th century. The Golden Gate of the St. Vitus Cathedral in Prague got its name from the golden 14th-century mosaic of the Last Judgement above the portal. It was executed by Venetian craftsmen.



A “painting” made from tesserae in St Peter's Basilica, Vatican State, Italy

The Crusaders in the Holy Land also adopted mosaic decoration under local Byzantine influence. During their 12th-century reconstruction of the Church of the Holy Sepulchre in Jerusalem they complemented the existing Byzantine mosaics with new ones. Almost nothing of them survived except the "Ascension of Christ" in the Latin Chapel (now confusingly surrounded by many 20th-century mosaics). More substantial fragments were preserved from the 12th-century mosaic decoration of the Church of the Nativity in Betlehem. The mosaics in the nave are arranged in five horizontal bands with the figures of the ancestors of Christ, Councils of the Church and angels. In the apses the Annunciation, the Nativity, Adoration of the Magi and Dormition of the Blessed Virgin can be seen. The program of redecoration of the church was completed in 1169 as a unique collaboration of the Byzantine emperor, the king of Jerusalem and the Latin Church.

In 2003, the remains of a mosaic pavement were discovered under the ruins of the Bizere Monastery near the River Mureş in present-day Romania. The panels depict real or fantastic animal, floral, solar and geometric representations. Some archeologists supposed that it was the floor of an Orthodox church, built some time between the 10th and 11th century. Other experts claim that it was part of the later Catholic monastery on the site

because it shows the signs of strong Italianate influence. The monastery was situated that time in the territory of the Kingdom of Hungary.

## **Renaissance and Baroque**

Although mosaics went out of fashion and were substituted by frescoes, some of the great Renaissance artists also worked with the old technique. Raffael's Creation of the World in the dome of the Chigi Chapel in Santa Maria del Popolo is a notable example that was executed by a Venetian craftsman, Luigi di Pace.

During the papacy of Clement VIII (1592–1605), the “Congregazione della Reverenda Fabbrica di San Pietro” was established, providing an independent organisation charged with completing the decorations in the newly-built St. Peter's Basilica. Instead of frescoes the cavernous Basilica was mainly decorated with mosaics. Among the explanations are:

1. The old St. Peter's Basilica had been decorated with mosaic, as was common in churches built during the early Christian era; the 17th century followed the tradition to enhance continuity.
2. In a church like this with high walls and few windows, mosaics were brighter and reflected more light.
3. Mosaics had greater intrinsic longevity than either frescoes or canvases.
4. Mosaics had an association with bejeweled decoration, flaunting richness.

The mosaics of St. Peter's often show lively Baroque compositions based on designs or canvases from like Ciro Ferri, Guido Reni, Domenichino, Carlo Maratta, and many others. Raphael is represented by a mosaic replica of this last painting, the Transfiguration. Many different artists contributed to the seventeenth- and 18th-century mosaics in St. Peter's, including Giovanni Battista Calandra, Fabio Cristofari (d. 1689), and Pietro Paolo Cristofari (d. 1743). Works of the Fabbrica were often used as papal gifts.



## The Christian East



Jerusalem on the Madaba Map

The eastern provinces of the Eastern Roman and later the Byzantine Empires inherited a strong artistic tradition from the Late Antiquity. Similarly to Italy and Constantinople churches and important secular buildings in Syria and Egypt were decorated with elaborate mosaic panels between the 5th and 8th centuries. The great majority of these works of art were later destroyed but archeological excavations unearthed many surviving examples.

The single most important piece of Byzantine Christian mosaic art in the East is the Madaba Map, made between 542 and 570 as the floor of the church of Saint George at Madaba, Jordan. It was rediscovered in 1894. The Madaba Map is the oldest surviving cartographic depiction of the Holy Land. It depicts an area from Lebanon in the north to the Nile Delta in the south, and from the Mediterranean Sea in the west to the Eastern Desert. The largest and most detailed element of the topographic depiction is Jerusalem, at the center of the map. The map is enriched with many naturalistic features, like animals, fishing boats, bridges and palm trees.

One of the earliest examples of Byzantine mosaic art in the region can be found on Mount Nebo, an important place of pilgrimage in the Byzantine era where Moses died. Among the many 6th-century mosaics in the church complex (discovered after 1933) the



most interesting one is located in the baptistery. The intact floor mosaic covers an area of 9 x 3 m and was laid down in 530. It depicts hunting and pastoral scenes with rich Middle Eastern flora and fauna.



Mosaic floor from the church on Mount Nebo (baptistery, 530)

The Church of Sts. Lot and Procopius was founded in 567 in Nebo village under Mount Nebo (now Khirbet Mukhayyat). Its floor mosaic depicts everyday activities like grape harvest. Another two spectacular mosaics were discovered in the ruined Church of Preacher John nearby. One of the mosaics was placed above the other one which was completely covered and unknown until the modern restoration. The figures on the older mosaic have thus escaped the iconoclasts.

The town of Madaba remained an important center of mosaic making during the 5-8th centuries. In the Church of the Apostles the middle of the main panel Thalassa, goddess of the sea, can be seen surrounded by fishes and other sea creatures. Native Middle Eastern birds, mammals, plants and fruits were also added.



The Transfiguration of Jesus in the Saint Catherine's Monastery

Important Justinian era mosaics decorated the Saint Catherine's Monastery on Mount Sinai. Generally wall mosaics have not survived in the region because of the destruction of buildings but the St. Catherine's Monastery is exceptional. On the upper wall Moses is shown in two panels on a landscape background. In the apse we can see the Transfiguration of Jesus on a golden background. The apse is surrounded with bands containing medallions of apostles and prophets, and two contemporary figure, "Abbot Longinos" and "John the Deacon". The mosaic was probably created in 565/6.

Jerusalem with its many holy places probably had the highest concentration of mosaic-covered churches but very few of them survived the subsequent waves of destructions. The present remains do not do justice to the original richness of the city. The most important is the so-called "Armenian Mosaic" which was discovered in 1894 on the Street of the Prophets near Damascus Gate. It depicts a vine with many branches and grape clusters, which springs from a vase. Populating the vine's branches are peacocks, ducks, storks, pigeons, an eagle, a partridge, and a parrot in a cage. The inscription reads: "For the memory and salvation of all those Armenians whose name the Lord knows." Beneath a corner of the mosaic is a small, natural cave which contained human bones dating to the 5th or 6th centuries. The symbolism of the mosaic and the presence of the burial cave indicates that the room was used as a mortuary chapel.

An exceptionally well-preserved, carpet-like mosaic floor was uncovered in 1949 in Bethany, the early Byzantine church of the Lazarium which was built between 333 and 390. Because of its purely geometrical pattern, the church floor is to be grouped with other mosaics of the time in Palestine and neighboring areas, especially the Constantinian



mosaics in the central nave at Bethlehem. A second church was built above the older one during the 6th century with another more simple geometric mosaic floor.



Detail from the mosaic floor of the Byzantine church of in Masada. The monastic community lived here in the 5-7th centuries.

The monastic communities of the Judean Desert also decorated their monasteries with mosaic floors. The Monastery of Martyrius was founded in the end of the 5th century and it was re-discovered in 1982-85. The most important work of art here is the intact geometric mosaic floor of the refectory although the severely damaged church floor was similarly rich. The mosaics in the church of the nearby Monastery of Euthymius are of later date (discovered in 1930). They were laid down in the Umayyad era, after a devastating earthquake in 659. Two six pointed stars and a red chalice are the most important surviving features.

classical tradition. During the Umayyad era Christianity retained its importance, churches were built and repaired and some of the most important mosaics of the Christian East were made during the 8th century when the region was under Islamic rule.

The mosaics of the Church of St Stephen in ancient Kastron Mefaa (now Umm ar-Rasas) were made in 785 (discovered after 1986). The perfectly preserved mosaic floor is the largest one in Jordan. On the central panel hunting and fishing scenes are depicted while another panel illustrates the most important cities of the region. The frame of the mosaic is especially decorative. Six mosaic masters signed the work: Staurachios from Ebus, Euremios, Elias, Constantinus, Germanus and Abdela. It overlays another, damaged, mosaic floor of the earlier (587) "Church of Bishop Sergius." Another four churches were excavated nearby with traces of mosaic decoration.

The last great mosaics in Madaba were made in 767 in the Church of the Virgin Mary (discovered in 1887). It is a masterpiece of the geometric style with a Greek inscription in the central medallion.

With the fall of the Umayyad dynasty in 750 the Middle East went through deep cultural changes. No great mosaics were made after the end of the 8th century and the majority of churches gradually fell into disrepair and were eventually destroyed. The tradition of mosaic making died out among the Christians and also in the Islamic community.





Detail from the mosaic floor of the Petra Church

Mosaic art also flourished in Christian Petra where three Byzantine churches were discovered. The most important one was uncovered in 1990. It is known that the walls were also covered with golden glass mosaics but only the floor panels survived as usual. The mosaic of the seasons in the southern aisle is from this first building period from the middle of the 5th century. In the first half of the 6th century the mosaics of the northern aisle and the eastern end of the southern aisle were installed. They depict native as well as exotic or mythological animals, and personifications of the Seasons, Ocean, Earth and Wisdom.

The Arab conquest of the Middle East in the 7th century did not break off the art of mosaic making. Arabs learned and accepted the craft as their own and carried on the





Apse mosaic "Glory of the Theotokos" in Gelati, Georgia. c. 1125-1130.

Prince Sviatopolk II built St. Michael's Golden-Domed Monastery in Kiev in 1108. The mosaics of the church are undoubtedly works of Byzantine artists. Although the church was destroyed by Soviet authorities, majority of the panels were preserved. Small parts of ornamental mosaic decoration from the 12th century survived in the Saint Sophia Cathedral in Novgorod but this church was largely decorated with frescoes.

Mosaics stopped being used for church decoration as early as the 12th century in the eastern Slavic countries. Later Russian churches were decorated with frescoes, similarly than orthodox churches in the Balkan.

The apse mosaic of the Gelati Monastery in Georgia from c. 1130 is probably the work of Byzantine mosaicist invited by King Demetre I. The fragmentary panel depicting the Theotokos flanked by two archangels looks thoroughly Byzantine (with Greek inscriptions). The use of mosaic in Gelati was a demonstration of the imperial ambition of the Bagrationids. The mosaic covered church could compete in magnificence with the churches of Constantinople. Gelati is the only monumental mosaic which survived in Georgia but fragments prove that the early churches of Pitsunda és Tsromi were also decorated with mosaic as well as other, lesser known sites. The destroyed 6th century mosaic floors in the Pitsunda Cathedral have been inspired by Roman prototypes. In Tsromi the tesserae are still visible on the walls of the 7th century church but only faint lines hint about the original scheme. Its central figure was Christ standing and displaying a scroll with Georgian text.

## Orthodox countries



Early 12th-century Kievan mosaic depicting St. Demetrius.

The craft has also been popular in early medieval Rus, inherited as part of the Byzantine tradition. Yaroslav, the Grand Prince of the Kievan Rus' built a large cathedral in his capital, Kiev. The model of the church was the Hagia Sophia in Constantinople, and it was also called Saint Sophia Cathedral. It was built mainly by Byzantine master craftsmen, sent by Constantine Monomachos, between 1037 and 1046. Naturally the more important surfaces in the interior were decorated with golden mosaics. In the dome we can see the traditional stern Pantokrator supported by angels. Between the 12 windows of the drum were apostles and the four evangelists on the pendentives. The apse is dominated by an orant Theotokos with a Deesis in three medallions above. Below is a Communion of the Apostles.



## Jewish mosaics



Zodiac wheel on the floor of the synagogue in Sepphoris

Under Roman and Byzantine influence Jews also decorated their synagogues with classical floor mosaics. Many interesting examples were discovered in Galilee and the Judean Desert.

The remains of a 6th-century synagogue have been uncovered in Sepphoris, which was an important centre of Jewish culture between the 3-7th centuries and a multicultural town inhabited by Jews, Christians and pagans. The mosaic reflects an interesting fusion of Jewish and pagan beliefs. In the center of the floor the zodiac wheel was depicted. Helios sits in the middle, in his sun chariot, and each zodiac is matched with a Jewish month. Along the sides of the mosaic are strips depicting Biblical scenes, such as the binding of Isaac, as well as traditional rituals, including a burnt sacrifice and the offering of fruits and grains.

Another zodiac mosaic decorated the floor of the Beit Alfa synagogue which was built during the reign of Justin I (518-27). It is regarded one of the most important mosaics discovered in Israel. Each of its three panels depicts a scene - the Holy Ark, the zodiac, and the story of the sacrifice of Isaac. In the center of the zodiac is Helios, the sun god, in his chariot. The four women in the corners of the mosaic represent the four seasons.



A third superbly preserved zodiac mosaic was discovered in the Severus synagogue in the ancient resort town of Hammat Tiberias. In the center of the 4th century mosaic the Sun god, Helios sits in his chariot holding the celestial sphere and a whip. Nine of the 12 signs of the zodiac survived intact. Another panel shows the Ark of Covenant and Jewish cultic objects used in the Temple at Jerusalem.

In 1936 a synagogue was excavated in Jericho which was named Shalom Al Israel synagogue after an inscription on its mosaic floor ("Peace on Israel"). It appears to have been in use from the 5th to 8th centuries and contained a big mosaic on the floor with drawings of the Ark of the Covenant, the Menorah, a Shofar and a Lulav. Nearby in Naaran, there is another synagogue (discovered in 1918) from the 6th century that also has a mosaic floor. Most of its figurative features were defaced by ultra-religious Jews, reflecting the controversiality of figurative art in synagogue decoration.

The synagogue in Eshtemoa (As-Samu) was built around the 4th century. The mosaic floor is decorated with only floral and geometric patterns. The synagogue in Khirbet Susiya (excavated in 1971-72, founded in the end of the 4th century) has three mosaic panels, the eastern one depicting a Torah shrine, two menorahs, a lulav and an etrog with columns, deer and rams. The central panel is geometric while the western one is seriously damaged but it has been suggested that it depicted Daniel in the lion's den. The Roman synagogue in Ein Gedi was remodelled in the Byzantine era and a more elaborate mosaic floor was laid down above the older white panels. The usual geometric design was enriched with birds in the center. It includes the names of the signs of the zodiac and important figures from the Jewish past but not their images suggesting that it served a rather conservative community.

The ban on figurative depiction was not taken so seriously by the Jews living in Byzantine Gaza. In 1966 remains of a synagogue were found in the ancient harbour area. Its mosaic floor depicts King David as Orpheus, identified by his name in Hebrew letters. Near him were lion cubs, a giraffe and a snake listening to him playing a lyre. A further portion of the floor was divided by medallions formed by vine leaves, each of which contains an animal: a lioness suckling her cub, a giraffe, peacocks, panthers, bears, a zebra and so on. The floor was paved in 508/509. It is very similar to that of the synagogue at Maon (Menois) and the Christian church at Shellal, suggesting that the same artist most probably worked at all three places.

The House of Leontius in Bet She'an (excavated in 1964-72) is a rare example of a synagogue which was part of an inn. It was built in the Byzantine period. The colorful mosaic floor of the synagogue room had an outer stripe decorated with flowers and birds, around medallions with animals, created by vine trellises emerging from an amphora. The central medallion enclosed a menorah (candelabrum) beneath the word shalom (peace).

A 5th-century building in Huldah may be a Samaritan synagogue. Its mosaic floor contains typical Jewish symbols (menorah, lulav, etrog) but the inscriptions are Greek. Another Samaritan synagogue with a mosaic floor was located in Bet She'an (excavated in 1960). The floor had only decorative motifs and an aedicule (shrine) with cultic

symbols. The ban on human or animal images was more strictly observed by the Samaritans than their Jewish neighbours in the same town (see above). The mosaic was laid by the same masters who made the floor of the Beit Alfa synagogue. One of the inscriptions was written in Samaritan script.

In 2003, a synagogue dating from the 5th or 6th century A.D. was uncovered in the coastal Ionian town of Saranda, Albania. It was the first time remains of an early synagogue have been found in that area, and the history of its excavation is also noteworthy. Albanian archaeologists first discovered remains 20 years earlier and thought them to be from a house of worship, but prohibition of religion under the tight Communist rule at the time prevented them from exploring it further. Mosaic finds at the site suggested a Jewish past, leading to a joint project began between Albanian archaeologists from the Institute of Archaeology in Albania and the Hebrew University Institute of Archaeology. The team found exceptional mosaics depicting items associated with Jewish holidays, including a menorah, ram's horn, and citron tree. Mosaics in the basilica of the synagogue show the facade of what resembles a Torah, animals, trees, and other biblical symbols. The structure measures 20 by 24 m. and was probably last used in the 6th century A.D. as a church.

## **Middle Eastern and Arab art**

### **Pre-Islamic Arabia**

In South Arabia two mosaic works were excavated in a Qatabanian from the late 3rd century AD, those two plates formed geometric and grapevines formation reflecting the traditions of that culture. In the Ghassanid era religious mosaic art flourished in their territory, so far five churches with mosaic were recorded from that era, two built by Ghassanid rulers and the other three by the Christian Arab community who wrote their names and dedications.



Floor pavement representing female dancers, Shapur palace, Bishapur.

## **Pre-islamic Persia**

Tilework had been known there for about two thousand years when cultural exchange between Sassanid Empire and Romans influenced Persian artists to create mosaic patterns. Shapur I decorated his palace with tile compositions depicting dancers, musicians, courtesans, etc. This was the only significant example of figurative Persian mosaic, which became prohibited after Arab conquest and arrival of Islam.

## **Islamic art**

### **Arab**

Islamic architecture used mosaic technique to decorate religious buildings and palaces since the Arabs conquered the eastern provinces of the Byzantine Empire. In Syria and



Egypt the Arabs were influenced by the great tradition of Roman and Early Christian mosaic art. During the reign of the Umayyad Dynasty mosaic making remained a flourishing art form in Islamic culture and it is continued in the art of (Azulejo) in various parts of the Arab world.

The first great religious building of Islam, the Dome of the Rock in Jerusalem, which was built between 688-692, was decorated with glass mosaics both inside and outside. Only parts of the interior decoration survived. The rich floral motives follow the Roman traditions, and "Islamic only in the sense that the vocabulary is syncretic and does not include representation of men or animals."



Islamic mosaics inside the Dome of the Rock in Jerusalem (c. 690)





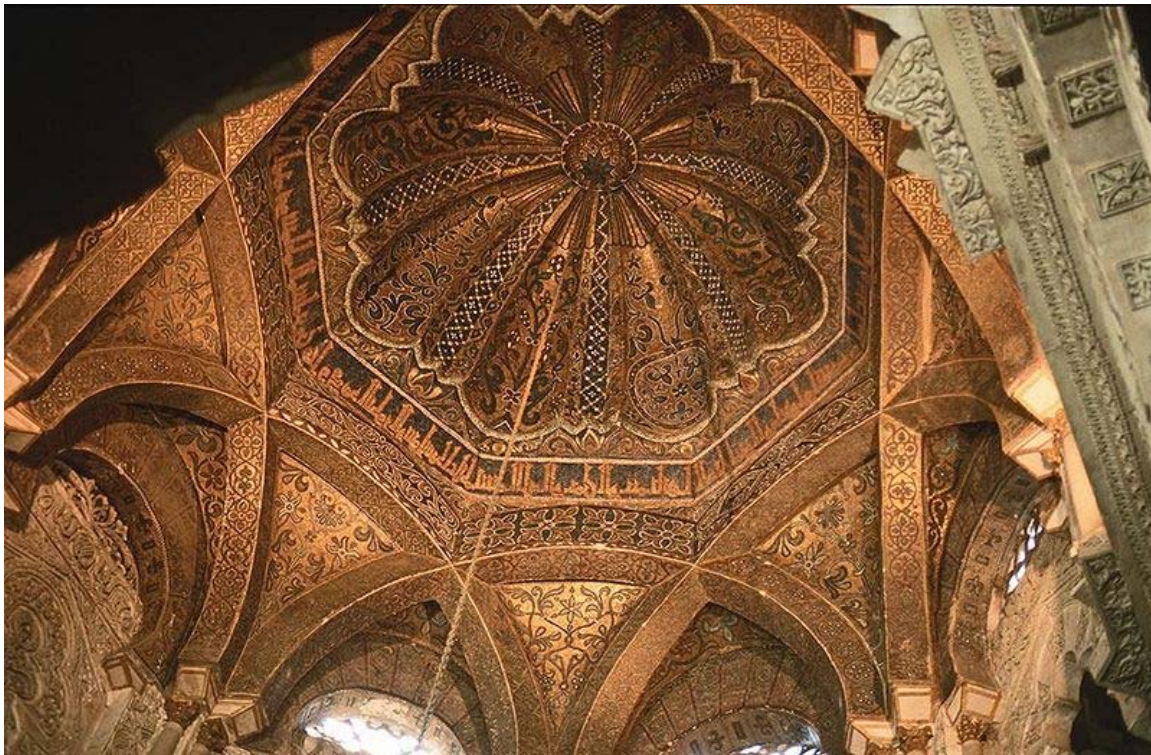
The Umayyad mosaics of Hisham's Palace closely followed classical traditions

The most important early Islamic mosaic work is the decoration of the Umayyad Mosque in Damascus, then capital of the Arab Caliphate. The mosque was built between 706 and 715. The caliph obtained 200 skilled workers from the Byzantine Emperor to decorate the building. This is evidenced by the partly Byzantine style of the decoration. The mosaics of the inner courtyard depict the Paradise with beautiful trees, flowers and small hill towns and villages in the background. The mosaics include no human figures, which makes them different from the otherwise similar contemporary Constantinopolitan works. The biggest continuous section survived under the western arcade of the courtyard. This section is called "Barada Panel" after the river Barada. It is thought that the mosque used to have the largest golden mosaic in the world, at over 4 m<sup>2</sup>. In 1893 a fire damaged the mosque extensively, and many mosaics were lost, although some have been restored since.

The mosaics of the Umayyad Mosque gave inspiration to later Damascene mosaic works. The Dome of the Treasury, which stands in the mosque courtyard, is covered with fine mosaics, probably dating from 13th- or 14th-century restoration work. The style of them are strikingly similar to the Barada Panel. The mausoleum of Sultan Baibars, Madrasa Zahiriyah, which was built after 1277, is also decorated with a band of golden floral and architectural mosaics, running around inside the main prayer hall.



Non-religious Umayyad mosaic works were mainly floor panels which decorated the palaces of the caliphs and other high-ranking officials. They were closely modeled after the mosaics of the Roman country villas, once common in the Eastern Mediterranean. The most superb example can be found in the bath house of Hisham's Palace, Palestine which was made around 744. The main panel depicts a large tree and underneath it a lion attacking a deer (right side) and two deers peacefully grazing (left side). The panel probably represents good and bad governance. Mosaics with classical geometric motifs survived in the bath area of the 8th century Umayyad palace complex in Anjar, Lebanon. The luxurious desert residence of Al-Walid II in Qasr al-Hallabat (in present-day Jordan) was also decorated with floor mosaics that show a high level of technical skill. The best preserved panel at Hallabat is divided by a Tree of Life flanked by "good" animals on one side and "bad" animals on the other. Among the Hallabat representations are vine scrolls, grapes, pomegranates, oryx, wolves, hares, a leopard, pairs of partridges, fish, bulls, ostriches, rabbits, rams, goats, lions and a snake. At Qastal, near Amman, excavations in 2000 uncovered the earliest known Umayyad mosaics in present-day Jordan, dating probably from the caliphate of Abd al-Malik ibn Marwan (685-705). They cover much of the floor of a finely decorated building that probably served as the palace of a local governor. The Qastal mosaics depict geometrical patterns, trees, animals, fruits and rosettes. Except for the open courtyard, entrance and staircases, the floors of the entire palace were covered in mosaics.



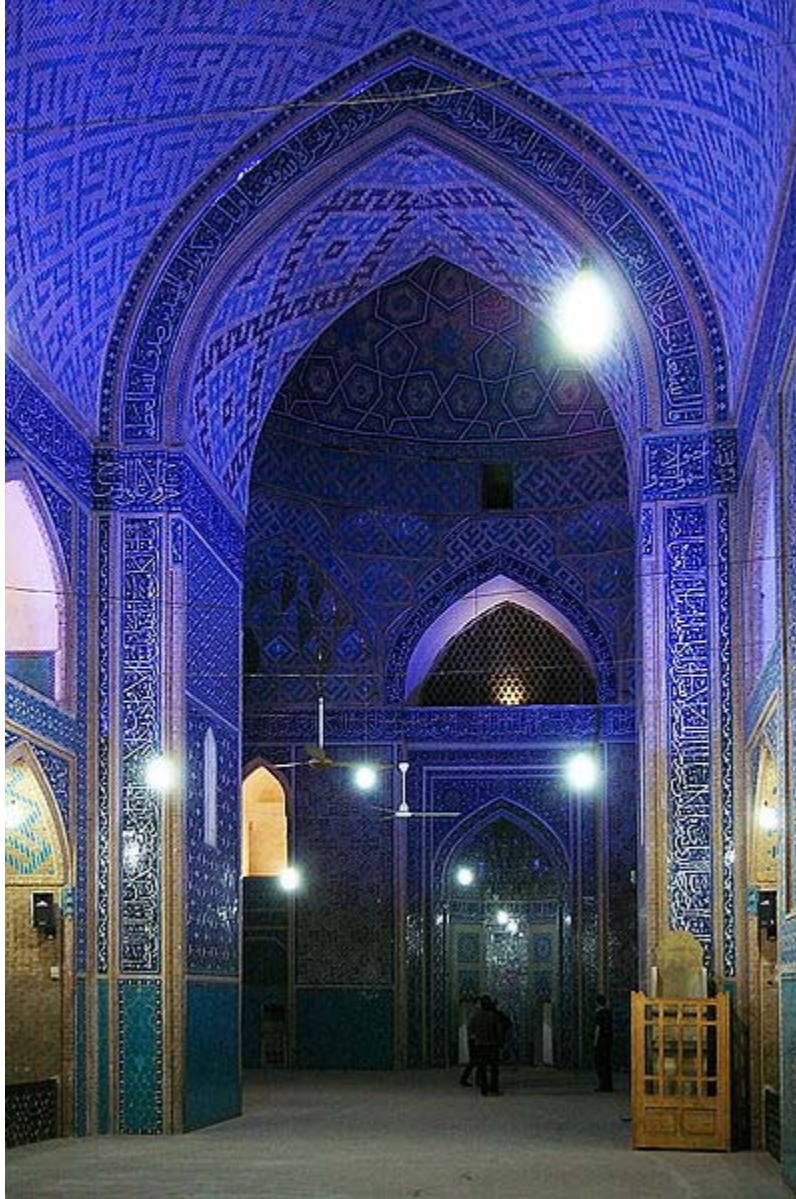
Golden mosaics in the dome of the Great Mosque in Cordoba (965-970)



Some of the best examples of later Islamic mosaics were produced in Moorish Spain. The golden mosaics in the mihrab and the central dome of the Great Mosque in Corduba have a decidedly Byzantine character. They were made between 965 and 970 by local craftsmen, supervised by a master mosaicist from Constantinople, who was sent by the Byzantine Emperor to the Umayyad Caliph of Spain. The decoration is composed of colorful floral arabesques and wide bands of Arab calligraphy. The mosaics were purported to evoke the glamour of the Great Mosque in Damascus, which was lost for the Umayyad family.

Mosaics similar to Roman ones generally went out of fashion in the Islamic world after the 8th century. Similar effect was reached by the use of geometric tilework, where the dominant types are zillij in North Africa and Qashani further east.

## Persian



Ceiling brickwork and tiled inscriptions in Jame mosque of Yazd.



Phoenix on the portal of Nadir Divan-Beghi Madrasah, Bukhara, Uzbekistan





A sculptural modern mosaic.

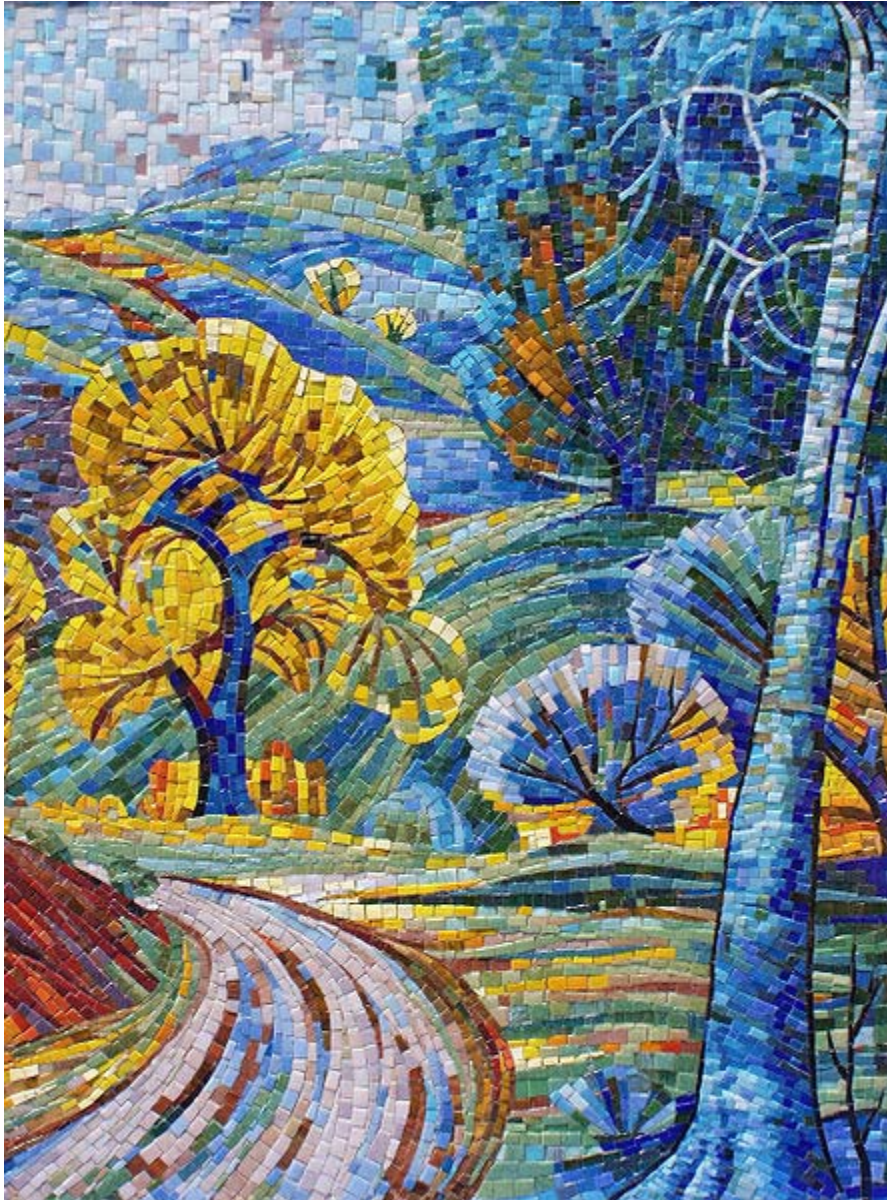
Early Islamic mosaics in Persia consist mainly of geometric decorations in mosques and mausoleums, made of glazed brick. Typical turquoise tile becomes popular in 10-11th century and is used mostly for Kufic inscriptions on mosque walls. Seyed Mosque in Isfahan (1122 AD), Dome of Maraqeh (1147 AD) and the Jame Mosque of Gonabad (1212 AD) are finest examples. The dome of Jame' Atiq Mosque of Qazvin is also dated to this period.

Golden age of Persian mosaic begins with Timurid Empire. Single color tiles were cut into small pieces and assembled by pouring liquid plaster between them. After hardening these panels were assembled on the walls of buildings. But the mosaic was not limited to flat areas. Jame Mosque in Yazd (1324-1365 AD) and Goharshad Mosque (1418 AD) are prominent examples of brick and tile mosaics of interiors and external surfaces of domes. Islamic buildings in Bukhara (16-17th century) also exhibit very sophisticated floral ornaments.

Mihrabs, being focus points of mosques, were usually the places where most sophisticated tilework was placed. 14th century mihrab at Madrasa Imami in Isfahan is an outstanding example of aesthetic union between the islamic calligrapher's art and abstract

ornament. The pointed arch, framing the mihrab's niche, bears an inscription in Kufic script used in ninth-century Qur'an.

One of the most known architectural masterpieces of Iran is the Shah Mosque in Isfahan, dated on 17th century. It's dome is a prime example of tile mosaic and it's winter praying hall houses one of the finest ensembles of *cuerda seca* tiles in the world. Wide variety of tiles had to be manufactured in order to cover complex forms of the hall with consistent mosaic patterns. The result was a technological triumph as well as a dazzling display of abstract ornament.



Glass tiles modern mosaic (detail).

During Safavid period mosaic ornaments were often replaced by *haft rang* (seven colors) technique. Pictures were painted on plain rectangle tiles, glazed and fired afterwards. Besides the economical reasons, seven colors method gave more freedom to artists and was less time-consuming. It was popular until Qajar period when the palette of colors was extended by yellow and orange.

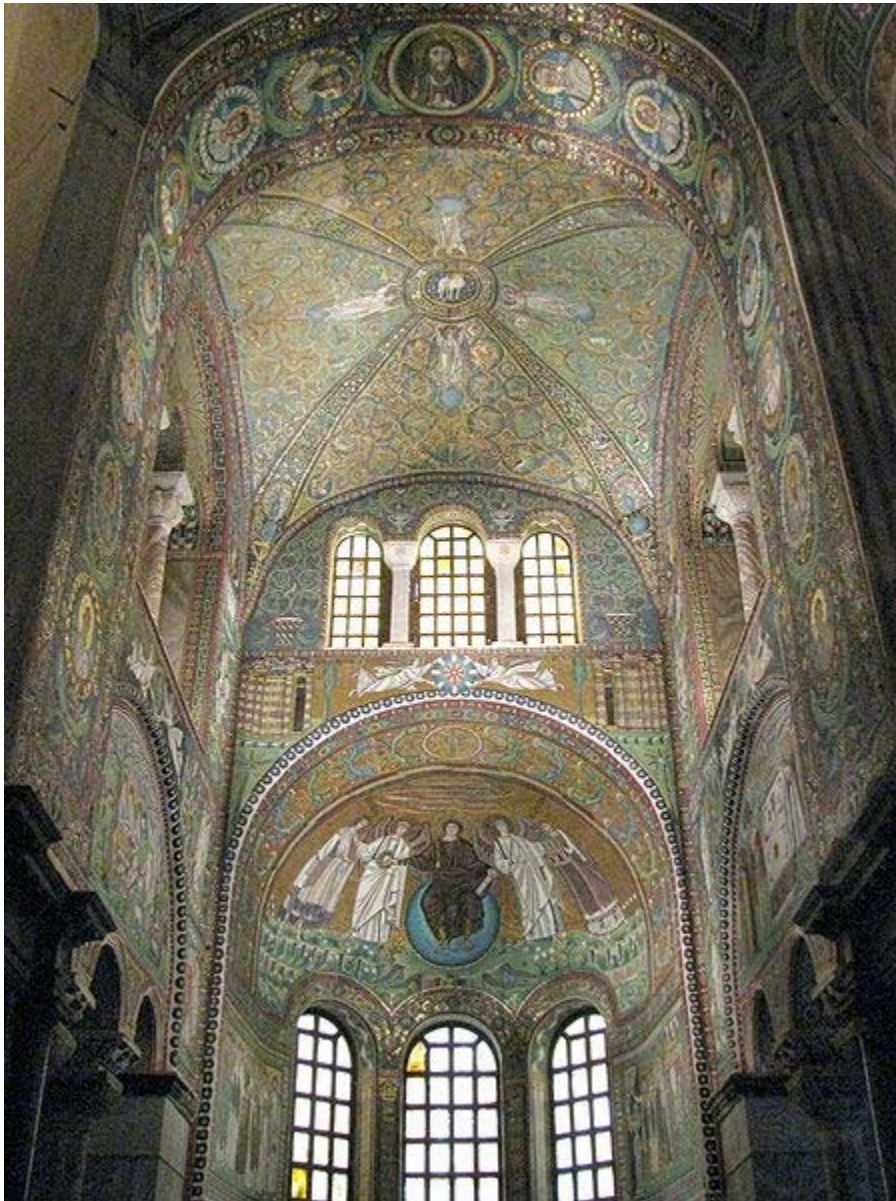
## **Modern mosaics**

Noted Nineteenth Century mosaics include those by Edward Burne-Jones at St Pauls within the Walls in Rome. A modern example of mosaic is the Museum of Natural History station of the New York Subway. Some modern mosaics are the work of *modernisme* style architects Antoni Gaudí and Josep Maria Jujol, for example the mosaics in the Park Güell in Barcelona. Today, among of the leading figures of the mosaic world are Emma Biggs (UK), Marcelo de Melo (Brazil), Sonia King (USA) and Saimir Strati (Albania).



## Chapter-2

# Late Antique and Medieval Mosaics in Italy



Basilica of San Vitale, Ravenna, 548

Italy has the richest concentration of Late Antique and medieval mosaics in the world. Although the technique is especially associated with Byzantine art, and many Italian mosaics were probably made by imported Greek-speaking artists and craftsmen, the numbers of significant mosaics remaining in the core Byzantine territories are surprisingly few. This is especially true for the centuries before the Byzantine Iconoclasm of the 8th century.

### ***Late Antique mosaics***



*The Great Hunt*; floor from the villa at Piazza Armerina, Sicily ca. 320. Figures are about life-size.



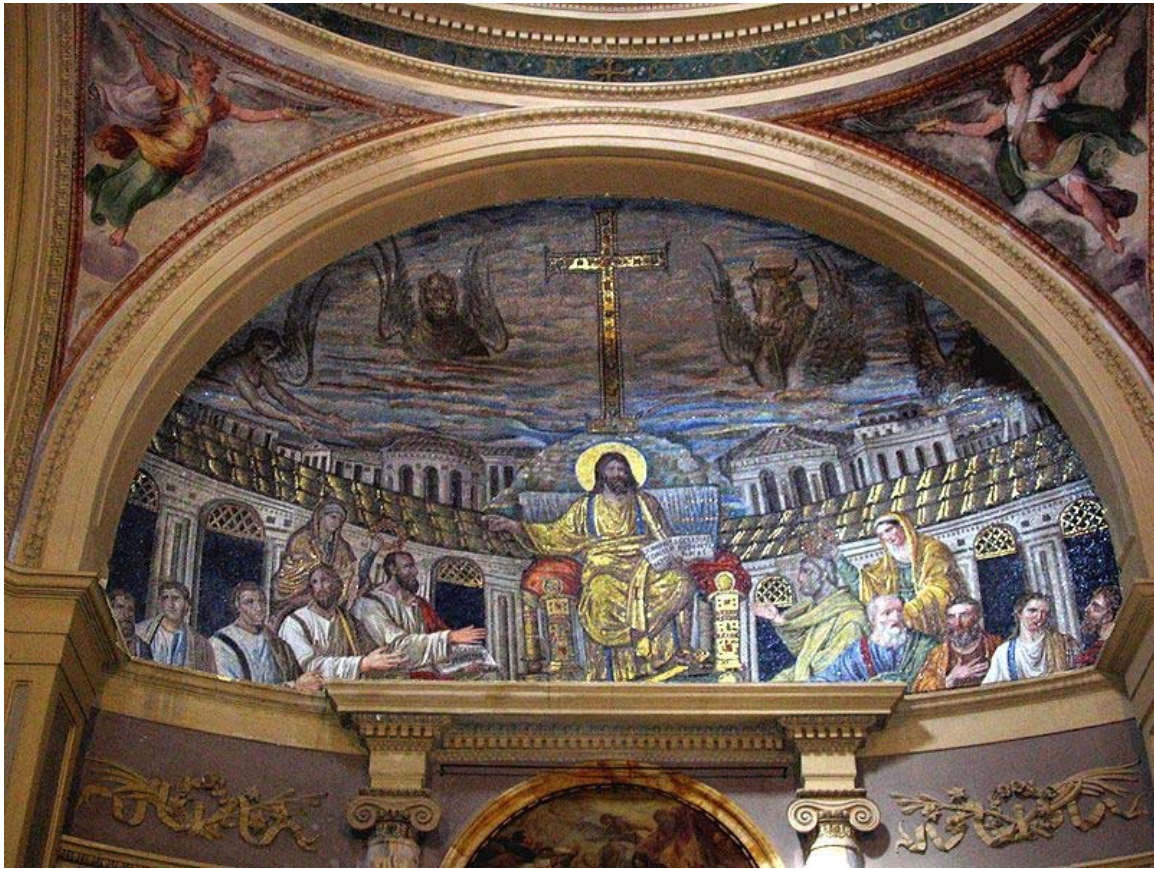


The story of Jonah, floor mosaic in Aquileia Cathedral, 314-318. Jonah is about life-size



Santa Costanza ceiling detail, 324-6





Santa Pudenziana apse mosaic, 384-9

"Early Roman mosaics belonged to the floor"; except in Nero's Domus Aurea, there is little evidence of ambitious wall mosaics before the Christian period, even at Pompeii and surrounding sites, where their chances of survival were better than elsewhere. The famous Alexander Mosaic (c. 100) from Pompeii, arguably the finest pre-Christian mosaic to survive, was a floor, and the main use of vertical mosaics there is in places unsuitable for frescos, such as fountains, baths and garden architecture including the very popular nymphaeum.

Sumptuous floor mosaics found by archaeology in villas continue into the Late Antique period, including those at the Villa Romana del Casale at Piazza Armerina and the Gladiator Mosaic, both of about the 320s. In contrast the floors of Early Christian churches contained very little figurative art, no doubt largely because it was considered inappropriate to walk on sacred images. The church floors are mostly geometrical, with small images in compartments of animals and the like, whereas the most important villa floors may contain huge scenes with many figures. The major surviving exception is the floor of the Cathedral at Aquileia, which is the earliest large area of Christian mosaic in Italy, dating to 314-18. This has large images of Christian symbols such as are seen in the Catacombs of Rome, including the Good Shepherd and Jonah and the whale, but no direct depictions of Christ. The Tomb of the Julii, under and pre-dating St Peter's, Rome

also has symbolic images, including a famous one of Christ as the sun god in his chariot. This subject also has the gold background not usually seen until the end of the century.

## **Late antique Rome**

### **Santa Costanza**

The fourth-century mosaics in the churches of Rome have few contemporary equivalents elsewhere. There were mosaics in the Lateran Basilica built by Emperor Constantine I from 312. The earliest to survive are in Santa Costanza, built under Constantine and the mausoleum of his daughters Constantina and Helena. The mosaics in the dome of biblical scenes, mostly from the Old Testament, and surrounded by a flowing river, were destroyed in 1620 and only survive in some sketches. The vaulted ceiling of the ambulatory retains its mosaics of 324-6 of various decorative designs with small birds, figures, pastoral scenes and putti in compartments in a geometric framework in some sections, and in arrangements of foliage in others. Despite the efforts of art historians to extract Christian symbolism from these components, the assembly is essentially derived from pagan decorative schemes for grand buildings. The work is of very high quality and in good condition, although restored. There is also a 5th-century apse mosaic of the *Traditio Legis* with a standing, lightly-bearded Christ with arm upraised. Some other scenes from the same period survive, heavily restored.

### **Santa Pudenziana**

Santa Pudenziana has an apse mosaic of 384-9 with an unusually complicated composition of the *Traditio Legis*. A heavily-bearded Christ sits on a rich jewelled throne below a large *crux gemmata* (jewelled cross) on a small mountain. Christ is flanked by two groups of five Apostles, headed by Saints Peter and Paul, who have laurel wreaths held over their heads by two female figures representing the church of the Jews and of the Gentiles respectively. Behind Christ stretches a portico with a tiled roof, above which a large cityscape of grand buildings can be seen. In the sky there are large Evangelists' symbols. The mosaic has been little restored.

### **Santa Maria Maggiore**

Santa Maria Maggiore has a large area of mosaics, probably of 432-440. They cover the apse, the "triumphal arch" (equivalent to the chancel arch), and sections, originally much larger, of the nave walls, where 27 of an original 42 panels remain from a sequence of scenes from the Old Testament. They are right at the top of the wall and hard to see. The apse mosaic is now mostly a Coronation of the Virgin of 1295 by Jacopo Torriti; probably it was originally all composed of the giant foliage scrolls that remain to the upper sides. San Clemente retains a similar apse mosaic, now a reworking of 1299, following the 5th century original. The triumphal arch has the earliest surviving monumental cycle of the *Life of the Virgin*, dedicatee of the church, and is thought to have been put up by Pope Sixtus III (432-40) to celebrate the Council of Ephesus, where Marian doctrine triumphed over the Nestorians.



## Santi Cosma e Damiano

The apse of Santi Cosma e Damiano (526-30) shows a raised-up standing Christ, bearded and in plain robes, with Saints Cosmas and Damian, Saint Theodore and Pope Felix IV being presented to him by Peter and Paul. Below this scene twelve sheep on a gold background represent the Apostles, flanking the Lamb of God. Both registers have grassy ground-levels, the upper one with rocks and plants, and two palm trees at the extreme sides. The faces are elongated in the Byzantine manner, and St Theodore wears the dress of a Byzantine courtier with a *tablion* and richly-patterned robe.

## Ravenna



Triumphal arch and apse semi-dome in Basilica of Sant' Apollinare in Classe, Ravenna (549)

Ravenna was made the capital of the Western Roman Empire (replacing Milan) in 402. It remained a capital until the 8th century, first of the Ostrogothic Kingdom from 493 and then after 540 the Byzantine Exarchate of Ravenna, before returning to the small-town status that has preserved its church buildings so well, though the palaces of the rulers and court have all been lost. Eight early Christian monuments of Ravenna, all with significant mosaics, are on the World Heritage List. These are:

- Neonian Baptistery ("Orthodox Baptistery") (c. 430)
- Mausoleum of Galla Placidia (c. 430)
- Arian Baptistery (c. 500)

- Archiepiscopal Chapel (c. 500)
- Basilica of Sant'Apollinare Nuovo (c. 500)
- Mausoleum of Theodoric (520)
- Basilica of San Vitale (548)
- Basilica of Sant' Apollinare in Classe (549)

## Other Cities



Basilica of San Lorenzo, Milan, with underdrawing revealed.

Milan was the main military centre of Northern Italy, controlling the roads to the north, and the effective capital of Constantius II, Constantine's son. The large octagonal Chapel of San Aquilino in the Basilica of San Lorenzo, Milan was perhaps built as an Imperial mausoleum for Galla Placidia about 400. It has an apse mosaic of a *Traditio Legis* with a beardless Christ in white robes flanked by the apostles, as part of a much larger scheme, now remaining only in fragments. In one area the mosaic has fallen away to reveal the underdrawing. There are some figures of saints and a dome of about 470 in Sant'Ambrogio.

Other relatively modest mosaics are found in several places, including a 5th-century domed ceiling in the baptistery of Naples Cathedral. Just outside modern Italy, but within the older borders, is the Euphrasian Basilica at Poreč (Parenzo), Istria with extensive mosaics of about 530 on the apse and triumphal arch. For the first time, the Virgin Mary, surrounded by saints, takes the centre of the apse semi-dome composition, with a beardless *Christ in Majesty* at the centre of the arch.



### ***Early Medieval mosaics (550-1200)***



Santa Prassede, ca 820

### **Rome**

Four churches in Rome have mosaics of saints near where their relics were held; these all show an abandonment of classical illusionism for large-eyed figures floating in space. Rome had been in Byzantine hands from 536-545, which may explain the change. They are San Lorenzo fuori le Mura (580s), Sant'Agnese fuori le mura (625-38), Santo Stefano Rotondo (640s), and the chapel of San Venanzio in the Lateran Basilica (c. 640) The only 8th century mosaics known are those in the tomb chapel of Pope John VII in Old St Peter's, which were recorded in drawings before the building was demolished, and of

which some fragments were salvaged. Around a central *Virgin Orans*, with the Pope kneeling to her, were three registers of scenes from the *Life of Christ*.

With the political stability brought about by the Frankish conquest of Italy there was a new burst of production of major Roman mosaics in the Carolingian period. The great hall (triclinium) of the Lateran Palace had religious mosaics in its apse-like semi-dome which survive, now moved outside and very heavily restored. Five churches in Rome have mosaics from this period: Santi Nereo e Achilleo (c. 814) has an iconographically eccentric programme at the east end, while Santa Prassede and Santa Cecilia in Trastevere (both c.820) and San Marco (commissioned between 828 and 848) all have semi-domes following that of Santi Cosma e Damiano (526-30 - above) with Saints Peter and Paul presenting martyrs and the donor Pope carrying a model of the church. Santa Maria in Domnica (c. 820) has an enthroned Madonna and Child in the midst of saints and angels.

## Monte Cassino



Monreale Cathedral, Sicily, after 1174.





Cappella Palatina, Palermo, after 1132.

By about the 10th century, the ability to produce high-quality mosaic work had been lost in Italy, and the best work was created by teams despatched by Byzantine Emperors as diplomatic favours. In the late 11th century local craftsmanship began to revive, no doubt with some initial Byzantine input. The important mosaics at Monte Cassino Abbey, made by Byzantine craftsmen between about 1066 and 1071, when Desiderius, the future Pope Victor III, was abbot, had all disappeared (except for small fragments) long before the abbey was destroyed by war in 1944. Their style was probably similar to the remaining sections of the scheme at Salerno Cathedral, created around 1085 by a close colleague of Desiderius. According to the abbey chronicler Leo of Ostia Desiderius ensured that monks learnt the skills of the Greek craftsmen.

## Norman Sicily

The Cappella Palatina is the royal chapel of the Norman kings of Sicily in the Palazzo Reale in Palermo, and was commissioned by Roger II of Sicily in 1132. Initially Greek craftsmen were imported, but later work appears to have been done, in a rather less refined style, by local craftsmen in the 1160s and 1170s.; Cefalù Cathedral was also begun by Roger with Greek artists in the 1130s, but the full scheme of mosaics was never



finished. The Martorana church in Palermo has mosaics from the same period, though in a slightly different style.

The Cathedral at Monreale was begun in 1174 and has the largest area of mosaic from before 1200 to survive in Italy. The Palazzo Reale and the castle at Zisa, Palermo have the only significant panels of secular mosaics to survive from the period, probably both of around 1170, both of which show considerable Islamic influence, though that may reflect the Byzantine style for such work. Confronted figures of birds, archers and lions are set around trees in geometric schemes.

## Venice



St Mark's Basilica in Venice.



The earliest remaining mosaics in the neighbourhood of Venice are on its early rival island Torcello, where the Cathedral has a late 12th century apse mosaic of famous beauty of the standing *Virgin Hodegetria*, isolated against a huge gold background. A *Last Judgement* on the west wall is of the same period; other mosaics in the cathedral are from the beginning of the 12th and perhaps the 11th centuries. The Church of Santa Maria e San Donato on the nearby island of Murano has a similar, but 13th century, Virgin apse mosaic, as well as a opus sectile floor from 1140.

The present St Mark's Basilica in Venice was begun in 1061, and its walls have been entirely decorated with mosaic, often replaced, with work continuing until the 17th century. St Mark's is the largest of the remaining handful of buildings, in Ravenna, Sicily, Turkey and Greece, which retain the unique impact of a full mosaic interior. Some traces of mosaic from before a devastating fire in 1106 probably remain, but the majority of the original mosaics date from the following three centuries, though often heavily restored or entirely redone as copies. They move from a Byzantinesque style to a more Romanesque one. Later Renaissance additions are fortunately not over-prominent, as they are generally regarded as unhappy mistakes.

Otto Demus believes that the early mosaics were created by local workshops aware of recent Byzantine work, and perhaps including, or trained by, Greeks. Whatever there may once have been, hardly any other mosaic work remains in the city.

### ***High Medieval period (1200-1400)***



Jacopo Torriti, Coronation of the Virgin, Santa Maria Maggiore, Rome, c. 1296

## Rome

In the 1220s the Pope needed to ask Venice for craftsmen to execute the apse mosaic of San Paolo Fuori le Mura, but towards the end of the century Rome was once again able to produce fine mosaics with local teams. From this period the artists responsible for their design begin to be known; they were primarily painters, and presumably mainly responsible for the design, working with specialist teams of mosaicists. The most significant of this first period are Pietro Cavallini, Jacopo Torriti and Giotto.

## Pietra dura

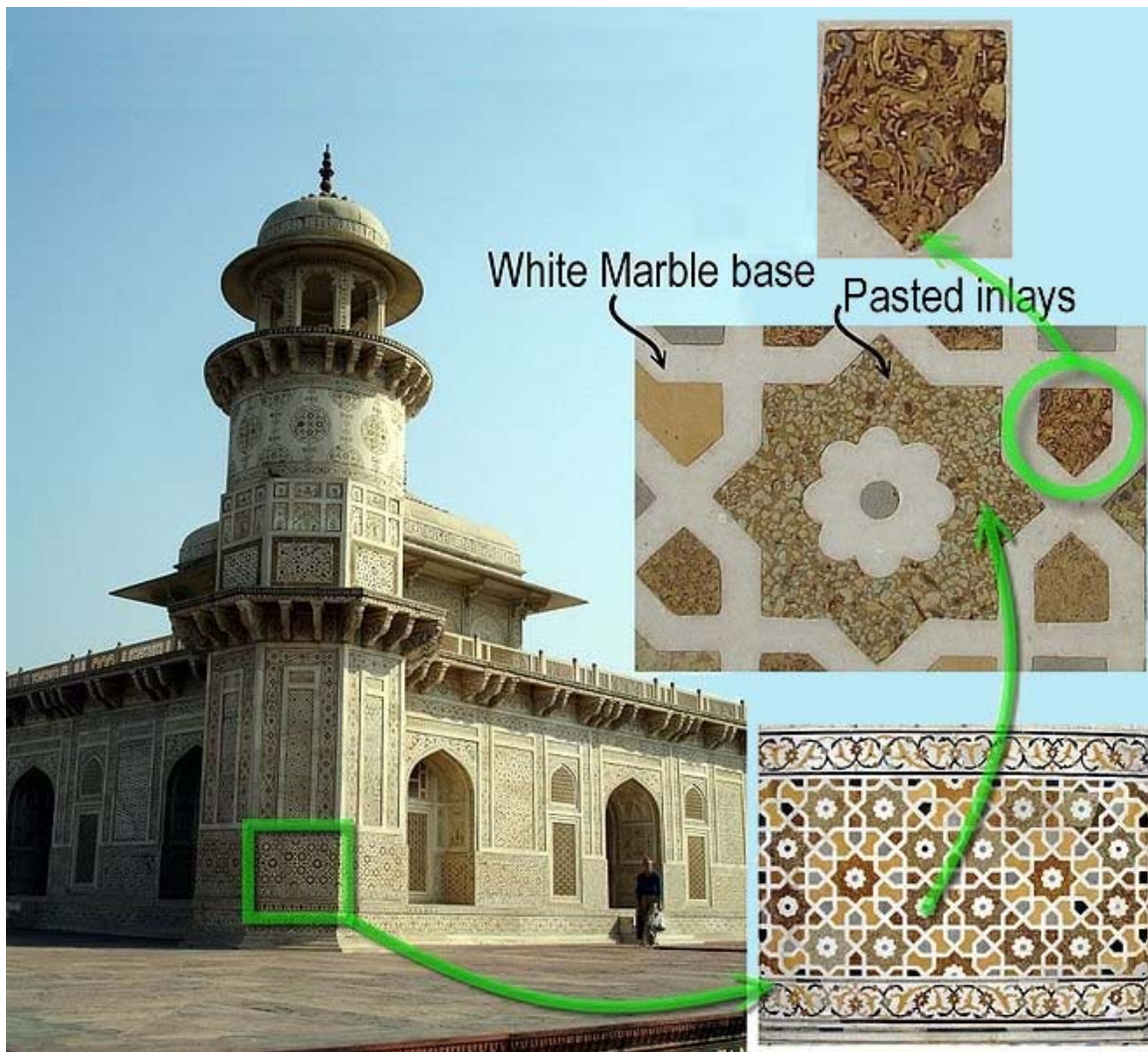


Pope Clement VIII in pietra dura designed by Jacopo Ligozzi, executed by Romolo di Francesco Ferrucci del Tadda.





Detail of design with roses over crossed canes, 1882



Itmad-Ud-Daulah's Tomb in Agra, India: Thanks to the meticulous and extensive use of pietra dura, the monument is often nicknamed as the “Jewel Box”.





Floral 'Parchin kari' work in the Taj Mahal, incorporating precious and semi-precious stones.

**Pietra dura** or *pietre dure* (see below), called **parchin kari** in South Asia, is a term for the technique of using cut and fitted, highly-polished colored stones to create images. It is considered a decorative art. The stonework, after the work is assembled loosely, is glued stone-by-stone to a substrate after having previously been "sliced and cut in different shape sections; and then assembled together so precisely that the contact between each section was practically invisible". Stability was achieved by grooving the undersides of the stones so that they interlocked, rather like a jigsaw puzzle, with everything held tautly in place by an encircling 'frame'. Many different colored stones, particularly marbles, were used, along with semiprecious, and even precious stones. It first appeared in Rome in the 16th century, reaching its full maturity in Florence. Pietra dura items are generally

crafted on green, white or black marble base stones. Typically the resulting panel is completely flat, but some examples where the image is in low relief were made, taking the work more into the area of hardstone carving.

## ***Related arts and terms***

Pietre dure is an Italian plural meaning "hard rocks"; the singular *pietra dura* is also encountered in Italian. In Italian, but not in English, the term embraces all gem engraving and hardstone carving, which is the artistic carving of three-dimensional objects in semi-precious stone, normally from a single piece, for example in Chinese jade. The traditional usage in English has been to use the singular *pietra dura* just to denote multi-colored inlay work. However in recent years there has been a trend to use *pietre dure* as a term for the same thing, but not for all the techniques it covers in Italian. But the title of a 2008 exhibition at the Metropolitan Museum of Art, New York *Art of the Royal Court: Treasures in Pietre Dure from the Palaces of Europe* used the full Italian sense of the term, probably because they thought it had greater brand recognition. The material on the website speaks of objects such as a vase in lapis lazuli as being examples of "hardstone carving (*pietre dure*)" The Victoria & Albert Museum in London uses both versions on its website, but *pietra dura* ("A method of inlaying coloured marbles or semi-precious stones into a stone base, often in geometric or flower patterns....") in its "Glossary", which was evidently not consulted by the author of another page, where the reader is told: "Pietre dure (from the Italian 'hard stone') is made from finely sliced coloured stones, precisely matched, to create a pictorial scene or regular design". The English term "Florentine mosaic" is sometimes also encountered, probably developed by the tourist industry.

It is distinct from mosaic in that the component stones are mostly much larger and cut to a shape suiting their place in the image, not all of roughly equal size and shape as in mosaic. In *pietra dura* the stones are not cemented together with grout, and works in *pietra dura* are often portable. Nor should it be confused with micromosaics, a form of mosaic using very small tesserae of the same size to create images rather than decorative patterns, for Byzantine icons, and later for panels for setting into furniture and the like.

For fixed inlay work on walls, ceilings and pavements that do not meet the definition for mosaic, the terms intarsia or cosmati work/cosmatesque are better used. Similarly, for works that use larger pieces of stone (or tile), opus sectile may be used. Pietre dure is essentially stone marquetry. As a high expression of lapidary art, it is closely related to the jewelers art. It can also be seen as a branch of sculpture as three-dimensionality can be achieved, as with a bas relief.

## ***History***

Pietra dura developed from the Ancient Roman opus sectile, which at least in terms of surviving examples, was architectural, used on floors and walls, with both geometric and figurative designs. In the Middle Ages cosmatesque floors and small columns etc on tombs and altars continued to use inlays of different colours in geometric patterns.



Byzantine art continued with inlaid floors, but also produced some small religious figures in hardstone inlays, for example in the Pala d'Oro in San Marco, Venice (though this mainly uses enamel). In the Italian Renaissance this technique again was used for images. The Florentines, who most fully developed the form, however, regarded it as 'painting in stone'. It is stated that Domenico Ghirlandaio "*dubbed the medium 'Pittura per l'eternità' -- that is, painting for eternity*".

As it developed in Florence, the technique was initially called *opere di commessi* (approximately, "Works of the commissariat"). Medici Grand Duke Ferdinando I of Tuscany founded the *Galleria di'Lavori* in 1588, now the Opificio delle pietre dure, for the purpose of developing this and other decorative forms.

A multitude of varied objects were created. Table tops were particularly prized, and these tend to be the largest specimens. Smaller items in the form of medallions, cameos, wall plaques, panels inserted into doors or onto cabinets, bowls, jardinières, garden ornaments, fountains, benches, etc. are all found. A popular form was to copy an existing painting, often of a human figure, as illustrated by the image of Pope Clement VIII, above. Examples are found in many museums. The medium was transported to other European centers of court art and remained popular into the 19th century. In particular, Naples became a noted center of the craft. By the 20th century, the medium was in decline, in part by the assault of modernism, and the craft had been reduced to mainly restoration work. In recent decades, however, the form has been revived, and receives state-funded sponsorship. Modern examples range from tourist-oriented kitsch including syrupy reproductions of 19th century style religious subjects (especially in Florence and Naples), to works copying or based on older designs used for luxurious decorative contexts, to works in a genuinely contemporary artistic idiom.

## ***Parchin Kari***

By the early part of the 17th century, smaller objects produced by the Opificio were widely diffused throughout Europe, and as far East to the court of the Mughals in India, where the form was imitated and reinterpreted in a native style; its most sumptuous expression is found in the Taj Mahal.

Due to the Taj Mahal being one of the major tourist attractions, there is a flourishing industry of Pietra Dura artifacts in Agra ranging from tabletops, medallions, elephants and other animal forms, jewellery boxes and other decorative items. This art form is fully alive and thriving in Agra, India though the patterns in the designs are more Persian than Roman or Medician.



19th century French sideboard with relief pietra dura panel





A contemporary marble table top in *Pietra Dura*, Agra, employing floral patterns of the Taj Mahal

## Chapter-3

### Early Byzantine Mosaics in the Middle East



Jerusalem on the Madaba Map

**Early Byzantine mosaics in the Middle East** are a group of Christian mosaics created between the 4th and the 8th centuries in ancient Syria, Palestine and Egypt when the area belonged to the Byzantine Empire. The eastern provinces of the Eastern Roman and later the Byzantine Empires inherited a strong artistic tradition from Late Antiquity. The tradition of making mosaics was carried on in the Umayyad era until the end of the 8th century. The great majority of these works of art were later destroyed but archeological excavations unearthed many surviving examples.



## ***The Madaba region***

The single most important piece of Byzantine Christian mosaic art in the East is the Madaba Map, made between 542 and 570 as the floor of the church of Saint George at Madaba, Jordan. It was rediscovered in 1894. The Madaba Map is the oldest surviving cartographic depiction of the Holy Land. It depicts an area from Lebanon in the north to the Nile Delta in the south, and from the Mediterranean Sea in the west to the Eastern Desert. The largest and most detailed element of the topographic depiction is Jerusalem, at the center of the map. The map is enriched with many naturalistic features, like animals, fishing boats, bridges and palm trees.



Mosaic floor from the church on Mount Nebo (baptistry, 530)

One of the earliest examples of Byzantine mosaic art in the region can be found on Mount Nebo, a place of pilgrimage in the Byzantine era where Moses died. Among the many 6th century mosaics in the church complex in an area known as Siyagha (discovered after 1933) the most interesting one is located in the baptistry. The intact floor mosaic in the Byzantine monastery, built on the foundations of an even earlier chapel from the third or fourth century CE, was laid down in circa 530. It covers an area of 9 x 3 m and depicts the monastic pastime of wine-making, as well as hunters, with a rich assortment of Middle Eastern flora and fauna.

The Church of Sts. Lot and Procopius was founded in 567 in Nebo village under Mount Nebo (now Khirbet Mukhayyat). Its floor mosaic depicts everyday activities like grape

harvest. Another two spectacular mosaics were discovered in the ruined Church of Preacher John nearby. One of the mosaics was placed above the other one which was completely covered and unknown until the modern restoration. The figures on the older mosaic have thus escaped the iconoclasts.

The town of Madaba remained an important center of mosaic making during the 5-8th centuries. In the Church of the Apostles even the name of the master mosaicist, Salomios was also recorded (from 568). In the middle of the main panel Thalassa, goddess of the sea, can be seen surrounded by fishes and other sea creatures. Native Middle Eastern birds, mammals, plants and fruits were also added. The Church of Prophet Elijah was built in 607. Its carpet-like central panel in the nave framed by a row of medaillons depicting native animals. Mosaic was used as a decoration not only for churches but for rich private residences like the Hippolytos Hall and the Burnt Palace (both from the early 6th century). They follow the classical Roman tradition with mythological and allegorical scenes like the Four Seasons, Phaedra and Hippolytos, Venus and Adonis, the Three Graces and the city goddesses of Madaba, Rome and Gregoria (in the Hippolytos Hall); hunting scenes, fight of a bull and a lion (in the Burnt Palace).

The early 7th century church complex of Tell Mar Elias, the birth place of Prophet Elijah, (in present-day Jordan, near Ajlun) was discovered in 1999. The floor of the cruciform main church is decorated with wonderfully intact, multi-colored mosaics with floral and geometric motifs (flowers, leaves, scrolls, braided patterns, amphorae) without any representations of animals or humans. One large mosaic floor inscription in white letters on a red background says that the presbyter Saba and his wife offered the church to God as an expression of their faith, in the year 622.

Another holy place, Bethany Beyond the Jordan (Al Maghtas), the scene of the baptism of Jesus, was excavated after 1994. Floor mosaics were discovered in the 5-6th century Church of the Arch, the Church of the Trinity and also the 5th century Rhotorios Monastery (with Greek inscriptions). The floor here was covered by a colored mosaic with a frame and cross marks depicted with geometrical designs. On the other side of the lower Jordan Valley another church was discovered in Khirbet el-Beiyudat (ancient Archelais). According to inscriptions its floor was paved with mosaics during the 560s.

The monastic complex above Lot's Cave (near the southern end of the Dead Sea), which was uncovered after 1988, contained five mosaics, one dated April 606, another May 691.





The Transfiguration of Jesus in the Saint Catherine's Monastery

Another important mosaic site around Madaba is ancient Ebus, present-day Tell Hesban where two Byzantine churches have been discovered. Both churches produced impressive remains of mosaic floors which is not surprising given the fact that Ebus was an ecclesiastical center with its own bishop. Particularly interesting is the nilotic mosaic of the presbytery of the North Church where the mosaicists have created a motif of a turtledove set on a nest made of an imaginary flower. Christian mosaics were also discovered in other settlements in the surroundings of Madaba like Ma'in and Massuh, testifying the widespread popularity of the craft in Byzantine times and the importance of the Madaba area as an artistic center. The church at Massuh has two layers of floor mosaics. The lower one, from the 6th century, has no iconoclastic damage, while the upper layer, from the 7th century, was systematically altered by iconoclasts. Figures were carefully replaced by crosses, or floral and architectural motifs.

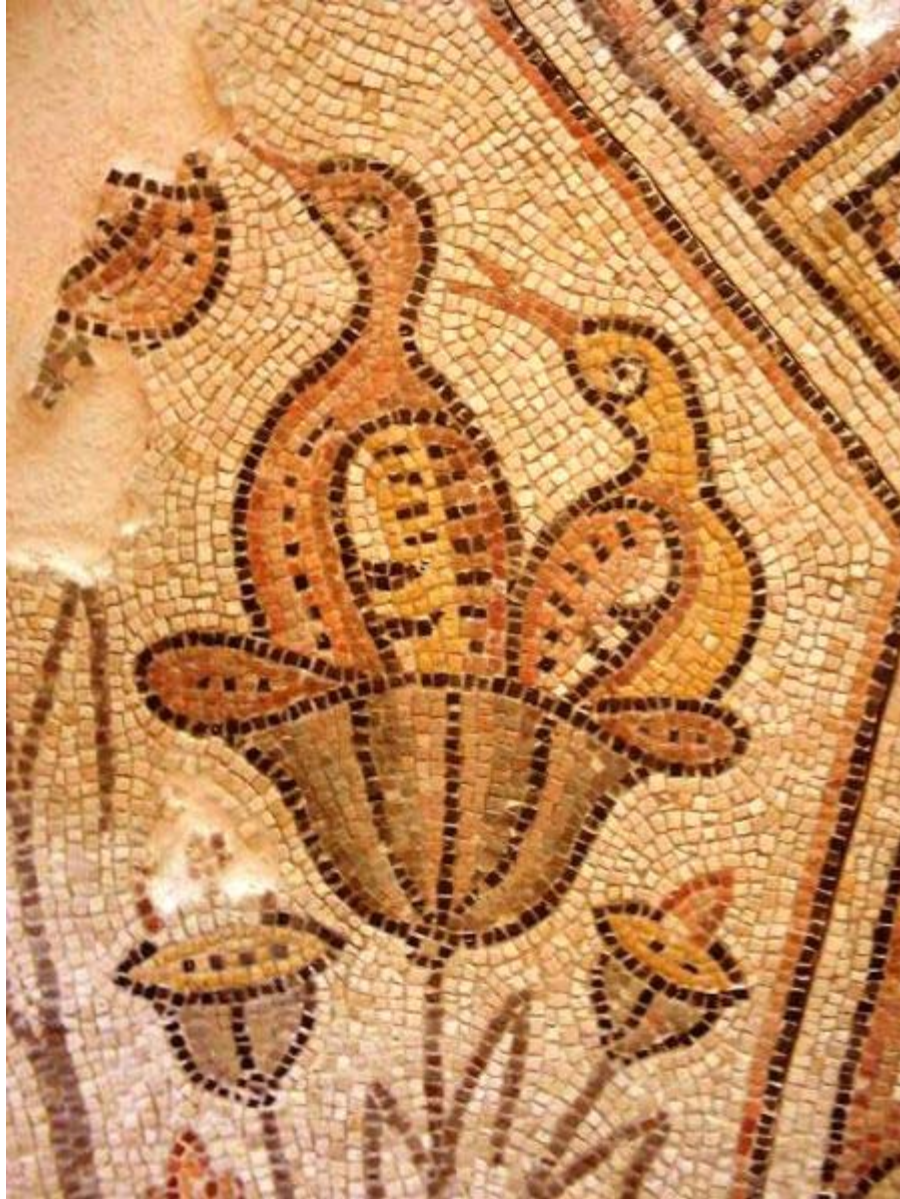
## **Egypt**

Important Justinian era mosaics decorated the Saint Catherine's Monastery on Mount Sinai. Generally wall mosaics have not survived in the region because of the destruction of buildings but the St. Catherine's Monastery is exceptional. On the upper wall Moses is shown in two panels on a landscape background. In the apse we can see the Transfiguration of Jesus on a golden background. The apse is surrounded with bands containing medallions of apostles and prophets, and two contemporary figure, "Abbot Longinos" and "John the Deacon". The mosaic was probably created in 565/6.

## ***The Holy Land***

Jerusalem with its many holy places probably had the highest concentration of mosaic-covered churches but very few of them survived the subsequent waves of destructions. The present remains do not do justice to the original richness of the city. The most important is the so-called "Armenian Mosaic" which was discovered in 1894 near the Damascus Gate. It depicts a vine with many branches and grape clusters, which springs from a vase. Populating the vine's branches are peacocks, ducks, storks, pigeons, an eagle, a partridge, and a parrot in a cage. The inscription reads: "For the memory and salvation of all those Armenians whose name the Lord knows." The symbolism of the mosaic indicates that the room was used to remember the dead as a mortuary chapel. In the Dominus Flevit Church on Mount Olives a 7th century Byzantine chapel was unearthed in 1955. The floor is richly decorated with intersecting circles and pictures of fruit, leaves, flowers, and fish. A Greek inscription mentions Simon, who "decorated this place of prayer in honor of Jesus". In the nearby Church of the Agony (built originally in the last decades of the 4th century) a colorful mosaic floor was discovered in 1920 which follows a geometric design. Fragments of a similar geometric mosaic floor were preserved in the Basilica of St. Stephen (outside the Damascus Gate) which was built by Empress Aelia Eudocia in the first half of the 5th century.





Detail of the mosaic floor from the church of Emmaus Nicopolis

On the outskirts of Jerusalem in the Monastery of the Cross a section of the elaborate 5th century mosaic floor survived, incorporating pictures of peacocks, plants and geometric patterns. Early Byzantine mosaics were preserved in the Church of John the Baptist in Ein Kerem, the Beit Jimal Monastery (in the 5th century the Church of the Tomb of St. Stephen, mosaics discovered in 1916), the Church of the Seat of Mary (Kathisma) (from the 5-8th centuries, floral and geometric designs, cornucopiae, discovered in 1992-7) and the lower church at Shepherds' Field (or Beit Sahour, the Greek Orthodox site, a floor including crosses, and therefore must predate 427). An exceptionally well preserved, carpet-like mosaic floor was uncovered in 1949 in Bethany, the early Byzantine church of the Lazarium which was built between 333 and 390. Because of its purely geometrical pattern, the church floor is to be grouped with other mosaics of the time in Palestine and



neighboring areas, especially the Constantinian mosaics in the central nave at Bethlehem. A second church was built above the older one during the 6th century with another more simple geometric mosaic floor. In 2003 during the construction works of the Israeli security barrier in Abu Dis workers damaged the remains of a Byzantine monastery which was subsequently excavated. The monastery church had an elaborate mosaic floor decorated with images of animals including a deer and an octopus.

Ruins of three Byzantine churches were discovered in the village of Beit Jibrin (ancient Eleutheropolis). One was decorated with an exquisite mosaic depicting the four seasons but it was defaced during the 1948 Arab-Israeli War. The other church north of the wadi was excavated in 1941-1942. Its floor mosaic have octagons with representations of birds, quadrupeds, and scenes from the story of Jonah depicting the prophet being thrown out of the boat or resting. In nearby Emmaus Nicopolis two Byzantine basilicas were built in the 6-7th centuries above the house of Cleopas, which was venerated by Christians as the place of the breaking of bread by the risen Christ. Both were decorated with mosaic floors. In the northern nave of the southern basilica, a nilotic mosaic portrayed birds, animals and flowers. In Abu Gosh a 5th century mosaic floor was preserved in the modern Church of the Ark of the Covenant.



Detail from the mosaic floor of the Byzantine church of in Masada. The monastic community lived here in the 5-7th centuries.



The monastic communities of the Judean Desert also decorated their monasteries with mosaic floors. The Monastery of Martyrius was founded in the end of the 5th century and it was re-discovered in 1982-85. The most important work of art here is the intact geometric mosaic floor of the refectory although the severely damaged church floor was similarly rich. The mosaics in the church of the nearby Monastery of Euthymius are of later date (discovered in 1930). They were laid down in the Umayyad era, after a devastating earthquake in 659. Two six pointed stars and a red chalice are the most important surviving features. The church floor was later replaced with rough *opus sectile* (probably by the Crusaders). In 1995-99 two large Byzantine churches were discovered in Khirbet Yattir (ancient Iethira) in the southern part of the Judean Desert. They belonged to monastic communities and were paved with beautiful mosaics in the 6-7th centuries. Two phases can be distinguished in the mosaic floor of Church C. The earlier was decorated with four birds and medallions of vines while the later one was divided into 23 strips which contain magical symbols and holy names. The dedicatory inscription dates this mosaic to the year 631/32.

The most important Byzantine mosaics in Samaria were discovered in Shilo where three basilicas were uncovered. The large mosaic floor of the Church of the Ark (completed in 420, re-discovered in 2006) contains geometric designs, flora representations and three Greek inscriptions, among them a salute to the residents of Seilun (Shilo).

## **Galilee**

Two mosaic sites were discovered in the vicinity of modern-day Nahariya in Western Galilee. One that now belongs to kibutz Shavey-Zion was a 5-6th century church that stood immediately on the seashore. The main motifs of its carpet-like, decorative floor are red swastikas on white background. The other church is located on a hill called Khirbet Ittaim. The tri-apsidal basilica was built in 555 by the bishop of Tyre and was destroyed in 614 by the Persians. The remarkable mosaic floor has figurative scenes like a hunter attacking a tiger in the south apse, a man with a horse, a sitting man playing a flute and two beautiful peacocks drinking from the fountain of life.

In 1940 a 6th century Byzantine church was discovered in present-day Hanita. Among the mainly decorative motifs of its mosaic floor there are two animal scenes: a boar grazing on a field and a hare eating grapes (the latter is very uncommon). Both are considered a symbol of redemption.

The mosaic decoration of the Church of the Annunciation in Nazareth, which was one of the great Constantinian basilicas of the Holy Land, was totally destroyed during the centuries together with much of the basilica. Archeological evidences prove that prior to the mid-4th century another small church stood on the site. A mosaic inscription referring to Deacon Conon survived of this building. The existence of a large Byzantine church on the site of the present-day Sisters of Nazareth convent was proven in 2006-2007. This church was architecturally complex and elaborately decorated, it was floored with polychrome mosaic (of which only very scant remains survived) and also had polychrome wall mosaics. Further mosaic-floored Byzantine buildings were located to

the south of the church. This evidence indicates that Byzantine Nazareth contained two large churches dominating its centre, with other mosaic-floored and colonnaded masonry structures around them. As such the town had to be an important Byzantine pilgrimage centre. On the top of nearby Mount Tabor which was venerated as the place of the Transfiguration of Christ another great church was built before 422. A small portion of its mosaic floor survived.

The Monastery of Lady Mary near Bet She'an was established in 567. Many rooms and the church itself was decorated with mosaic among them a great zodiac, a circle of 12 figures representing the months, with the sun god Helios and the moon goddess Selene in the centre. Similar mosaic zodiacs were found in contemporary Jewish synagogues. Other mosaics represent vine tendrils, hunters, animals and birds.

### ***Petra and the desert***



Detail from the mosaic floor of the Petra Church



Mosaic art also flourished in Christian Petra where three Byzantine churches were discovered. The most important one was uncovered in 1990. It is known that the walls were also covered with golden glass mosaics but only the floor panels survived as usual. The mosaic of the seasons in the southern aisle is from this first building period from the middle of the 5th century. In the first half of the 6th century the mosaics of the northern aisle and the eastern end of the southern aisle were installed. They depict native as well as exotic or mythological animals, and personifications of the Seasons, Ocean, Earth and Wisdom.

Mosaic covered churches prove that the towns along the Nabatean spice road in the Negev Desert flourished in the Christian era. In Mamshit two great churches survived. The Eastern Church (or Church of the Martyrs) was probably built in the late 4th century and has a geometric floor with crosses. The mosaics of the Western (or Nile) Church are more elaborate depicting birds, fruit basket, swastikas and flowers. An inscription in a medallion reads: "God, save your servant Nilus, lover of Jesus, who founded this building. Preserve him and his household."

Several mosaics were discovered around Gaza which was an important centre of Christianity during the Byzantine era. The most publicized of these discoveries were made in 1917 by Australian troops fighting against the Ottomans at Shellal. The church stood upon a small hill above Wadi Guzze and has an elaborate floor decorated exotic animals in medallions and two beautiful peacocks. It was dated to 561-562 and it is regarded an extraordinary piece of Justinian era mosaic art. A lesser known mosaic of a church was also uncovered during military operations in the summer of 1917 at Umm Jerar, south of Gaza. Two floors have many similarities in design.

In the Barnea district of the port of Ashkelon two large Byzantine churches were unearthed. In the first only the remains of glass tesserae prove that its walls were decorated with mosaics while in the other one an almost intact geometric floor survived with three inscriptions dating to years 493 and 498.

## ***Lebanon***

As part of ancient Syria, present-day Lebanon shared the same great tradition in Roman and Byzantine mosaic art as neighbouring areas. In the recent past many important finds were brought to light in cities and churches all over the country. An important Byzantine mosaic collection was established in Beiteddine Palace, mostly from discoveries in the coastal town of Jiyeh (ancient Porphyron). They date from the 5-6th centuries. The designs are often geometric and stylized but there are also interesting depictions animals, including leopards, gazelles, lions, hares and birds, as well as religious figures.

A big geometric mosaic floor was unearthed in the Church of St John the Baptist in Byblos.



Fifth c. Mosaic of the goddess Ktisis (KTICIC) at the Beiteddine Palace.



## ***The Umayyad era***

The Arab conquest of the Middle East in the 7th century did not break off the art of mosaic making. Arabs learned and accepted the craft as their own and carried on the classical tradition. During the Umayyad era Christianity retained its importance, churches were built and repaired and some of the most important mosaics of the Christian East were made during the 8th century when the region was under Islamic rule.

The mosaics of the Church of St Stephen in ancient Kastron Mefaa (now Umm ar-Rasas) were made in 785 (discovered after 1986). The perfectly preserved mosaic floor is the largest one in Jordan. On the central panel hunting and fishing scenes are depicted while another panel illustrates the most important cities of the region (including Kastron Mefaa, Philadelphia, Madaba, Esbounta, Belemounta, Areopolis, Charac Moaba, Jerusalem, Nablus, Caesarea and Gaza). The frame of the mosaic is especially decorative. Six mosaic masters signed the work: Staurachios from Esbus, Euremios, Elias, Constantinus, Germanus and Abdela. It overlays another, damaged, mosaic floor of the earlier (587) "Church of Bishop Sergius." Another four churches were excavated nearby with traces of mosaic decoration.

The mosaic floors of the Acropolis Church at Ma'in (ancient Belemounta), dated by an inscription to 719–20 include depictions of 11 buildings representing cities in the Holy Land, as identified by Greek toponyms. All figures were damaged by iconoclasts and carefully replaced with various motifs.

The last great mosaics in Madaba were made in 767 in the Church of the Virgin Mary (discovered in 1887). It is a masterpiece of the geometric style with a Greek inscription in the central medallion.

With the fall of the Umayyad dynasty in 750 the Middle East went through deep cultural changes. No great mosaics were made after the end of the 8th century and the majority of churches gradually fell into disrepair and were eventually destroyed. The tradition of mosaic making died out among the Christians and also in the Islamic community.



Fifth c. Mosaic of two doves and a swastika at the Beiteddine Palace.



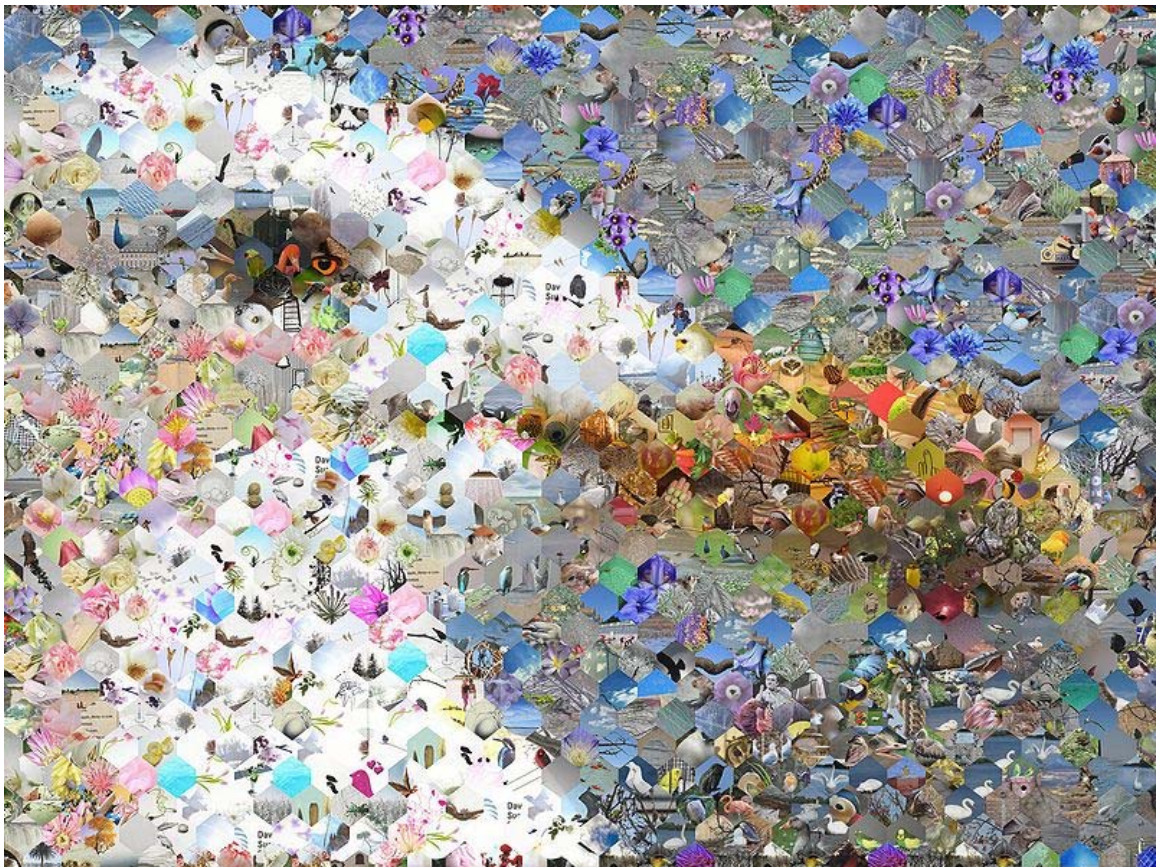
Fifth c. Mosaic of a bull and a lion at the Beiteddine Palace.



## Chapter-4

# Photographic Mosaic and Color Filter Mosaic

## Photographic Mosaic



A photographic mosaic of a sea gull made from pictures of birds and other nature photos using hexagonal tiles

In the field of photographic imaging, a **photographic mosaic** (also known under the term **Photomosaic**, a portmanteau of photo and mosaic, trademarked by Runaway Technology, Inc.) is a picture (usually a photograph) that has been divided into (usually equal sized) rectangular sections, each of which is replaced with another photograph of appropriate average color. When viewed at low magnifications, the individual pixels

appear as the primary image, while close examination reveals that the image is in fact made up of many hundreds or thousands of smaller images. They are a computer-created type of montage.

Originally, the term *photomosaic* referred to compound photographs created by stitching together a series of adjacent pictures of a scene. Space scientists have been assembling mosaics of this kind since at least as early as the Soviet Union space satellite missions to the moon in the late 1950s.

## History

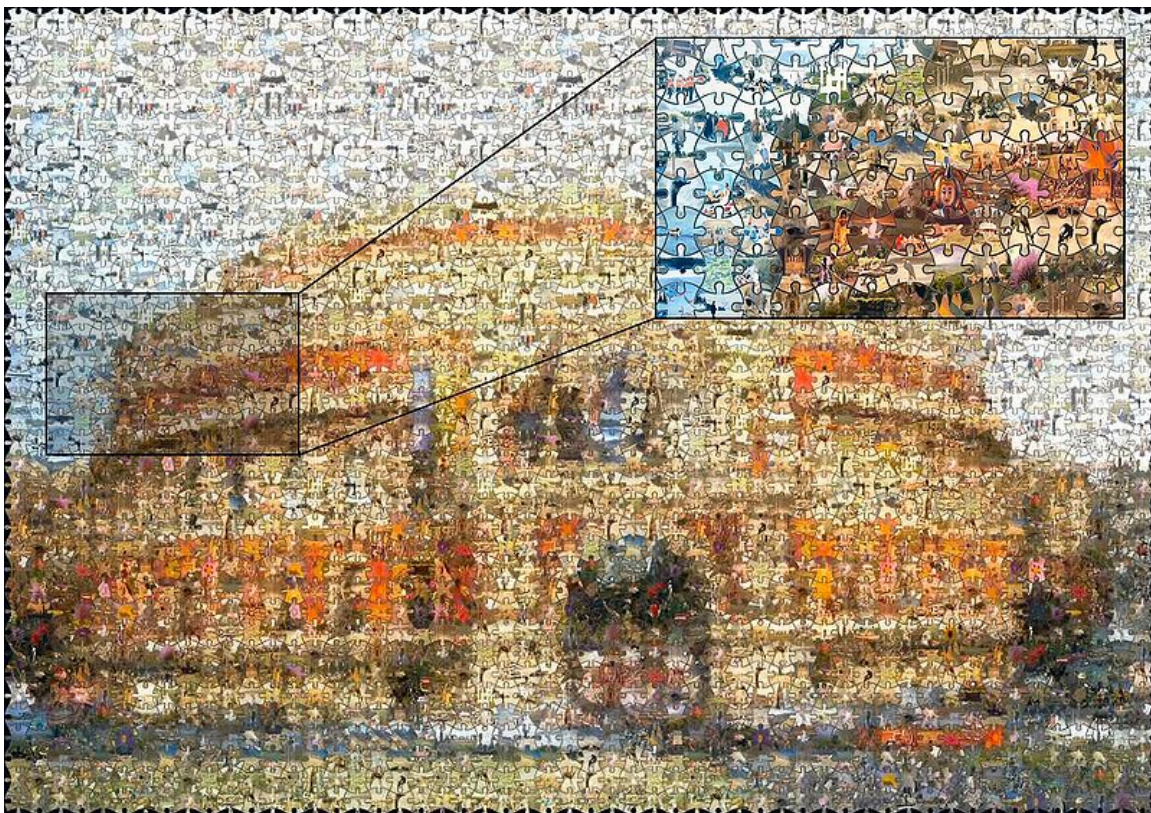


1993 *Live from Bell Labs* event poster

- **1993** Joseph Francis, working for R/Greenberg Associates in Manhattan, is believed to be the inventor of the modern-day computer-generated colour image versions. His *Live from Bell Labs* poster created in 1993 used computer-themed tile photographs to create a mosaic of a face ( Ryszard Horowitz/ Photography and Art Direction, Robert Bowen/ Digital Artist). He went on to create a mosaic for *Animation Magazine* in 1993, which was repeated in *Wired Magazine* (November 1994, p. 106). Francis has said on his "History of Photo Mosaics" webpage that his interest in developing these techniques further was in part stimulated by the work of artist Chuck Close.
- **1994** Dave McKean creates an image for DC Comics, a mosaic of a face made from photos of faces, although this is believed to be created manually using Photoshop.



- **1994** Adam Finkelstein and Sandy Farrier create a mosaic of John F. Kennedy from parts of Marilyn Monroe pictures. The result was displayed in the Xerox PARC Algorithmic Art Show in 1994.
- **1994** Benetton: AIDS - Faces mosaic. Over one thousand young peoples' portraits from all over the world computer-processed spell out the word AIDS.
- **1995** The *Gioconda Sapiens*, a face with ten thousand faces, was presented to the public in April 1995 (Spain, Domus museum). This was the first large photographic mosaic, using photographs of 10,062 people from 110 countries to make the *Mona Lisa*.
- **1995** Adam Finkelstein (published mosaic in Mossy Bits) creates a mosaic of the oil painting *American Gothic* from images collected from the Web in early 1995.



2000 Puzzle photographic mosaic of the Royal Albert Hall

- **1995** Robert Silvers creates a Photomosaic and goes on to trademark the term Photomosaic and patent creation of Photomosaics in 1997.
- **2000** Andrej Olejnik creates the first pattern-based photographic mosaics rendered with Mosaic Creator software.

- **2003** Doubletake Images creates the world's largest photographic mosaic—over 10,000 square feet (1,000 m<sup>2</sup>). The live event took place at Disneyland and was created by thousands of castmembers holding up photographs of themselves.
- **2004** Roy Feinson creates a series of 38 giant mosaic murals to celebrate Disneyland's 50th Anniversary in which 250,000 guest-submitted photographs were used. The project included the first tri-level mosaic, comprising an image of Steamboat Willie made up of photographs of Disney castmembers, which themselves were mosaics made up of over 150,000 guest photographs.
- **2006** Picture Mosaics creates the first 3D scatter mosaic for Fox's hit show *American Idol*. The technique uses photos that are rotated in varying degrees and overlapping each other to mimic the effect of a collection of photos that are scattered across a surface. View the scatter mosaic example

## ***Intellectual property***

Robert Silvers, a Master's student at MIT, filed for a trademark on the term *Photomosaic* on September 3, 1996. This trademark was registered on August 12, 2003.

Silvers also applied for a U.S. patent on the production of Photomosaics on January 2, 1997, which was granted as US patent 6137498 in October 2000 and has been assigned to Runaway Technology, Inc. Patent applications in other countries were also filed, and patents granted include EP patent 0852363, JP patent 10269353, CA patent 2226059, and AU patent 723815B. He is quoted as saying: "By being granted this patent in the United States and other countries, we can protect our proprietary innovations and continue to make unique artwork." In September 2008, the Public Patent Foundation filed a formal request with the United States Patent and Trademark Office (USPTO) to review certain claims in the US patent 6137498 on photomosaics. The request was granted and a reexamination proceeding ensued. On August 31, 2010, the USPTO issued a Reexamination Certificate confirming the patentability of all claims in the patent which were amended to refer to shape matching (a feature that contributes to the high resolution of photomosaics).

There are a number of other commercial companies that create mosaics with photos. Since there has been no litigation of these patents, these companies must therefore either use processes that do not infringe on the particular claimed process, have licenses under the patents, or are infringing those patents but Runaway Technology has chosen not to bring infringement proceedings.

Silvers' patent may be regarded as a software patent, a subject over which there is a great deal of debate. For example, Article 52(2)(c) EPC states that "programs for computers as such" are not regarded as patentable inventions. Nevertheless, current practice relating to computer-implemented inventions under the EPC means that a process that provides a technical effect may be patented even if it is implemented by a computer.



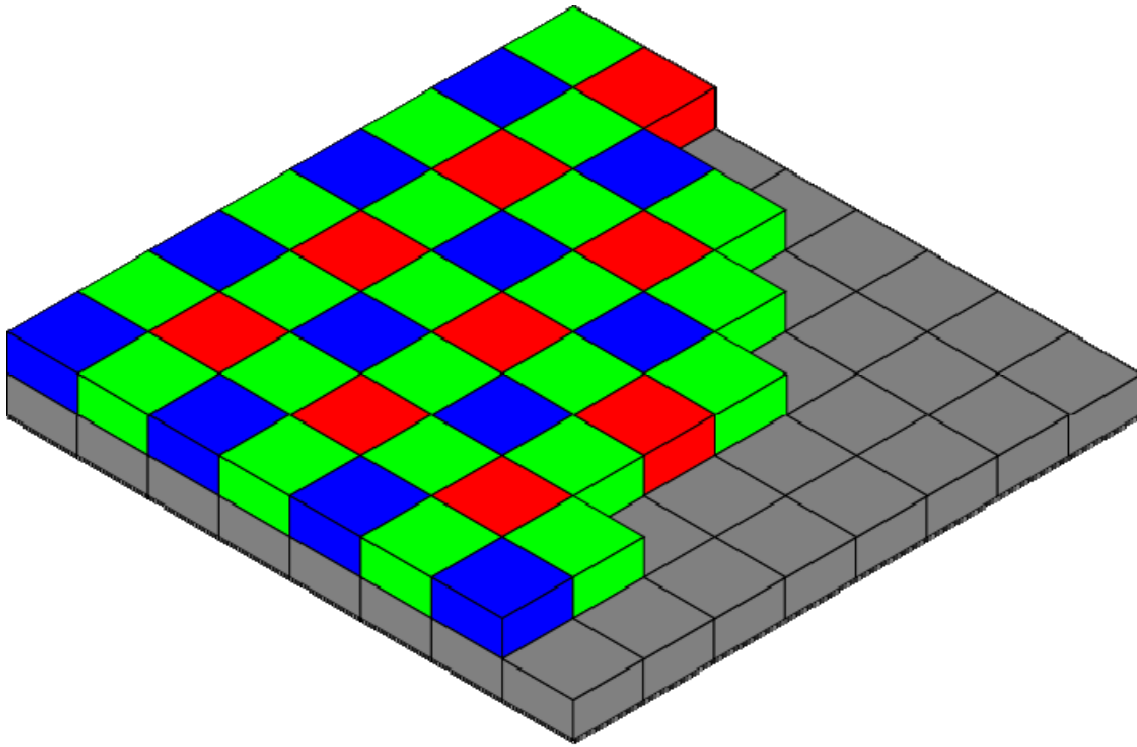
The UK patent deriving from EP patent 0852363 became the subject of revocation proceedings in July 2006. In September 2009, the UK Intellectual Property Office (UK-IPO) decided that the patent should not be revoked and terminated the proceeding. This decision was made by the UKIPO and not the European Patent Office (EPO) which originally granted the patent since no opposition to the European patent was filed within the nine-month post-grant period.

## ***Video mosaic***

Photographic mosaics are typically formed from a collection of still images. A more recent phenomenon, however, has been the use of video mosaics where, instead of using still images, video clips are assembled to create a larger image. As an example, the closing credits of the 2005 PlayStation 2 game *God of War* incorporated a still image of the main character, Kratos, formed from a number of in-game videos. An example of a high-definition video mosaic has been posted on the Picturemosaics website.

Another definition of the term video mosaic is the creation of one large still image from the stitching together of adjacent frames of video. A common application of this is with aerial video taken of a geographic feature like a road or a city. Instead of having to watch an entire video to get an idea of what the feature looks like, a mosaic of the relevant frames can be generated. Mosaicing or mosaicking can be used to save both time and bandwidth, since still images are much smaller than video.

# Color filter Mosaic



The Bayer color filter mosaic. Each two-by-two submosaic contains 2 green, 1 blue and 1 red filter, each covering one pixel sensor.

In photography, a **color filter array (CFA)**, or **color filter mosaic (CFM)**, is a mosaic of tiny color filters placed over the pixel sensors of an image sensor to capture color information.

Color filters are needed because the typical photosensors detect light intensity with little or no wavelength specificity, and therefore cannot separate color information. Since sensors are made of semiconductors they obey solid-state physics.

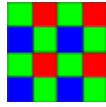
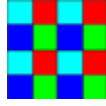
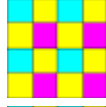

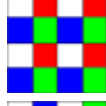


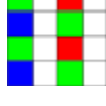
The color filters filter the light by wavelength range, such that the separate filtered intensities include information about the color of light. For example, the Bayer filter (shown to the right) gives information about the intensity of light in red, green, and blue (RGB) wavelength regions. The raw image data captured by the image sensor is then converted to a full-color image (with intensities of all three primary colors represented at each pixel) by a demosaicing algorithm which is tailored for each type of color filter. The spectral transmittance of the CFA elements along with the demosaicing algorithm jointly determine the color rendition. The sensor's passband quantum efficiency and span of the CFA's spectral responses are typically wider than the visible spectrum, thus all visible



colors can be distinguished. The responses of the filters do not generally correspond to the CIE color matching functions, so a color translation is required to convert the tristimulus values into a common, absolute color space.

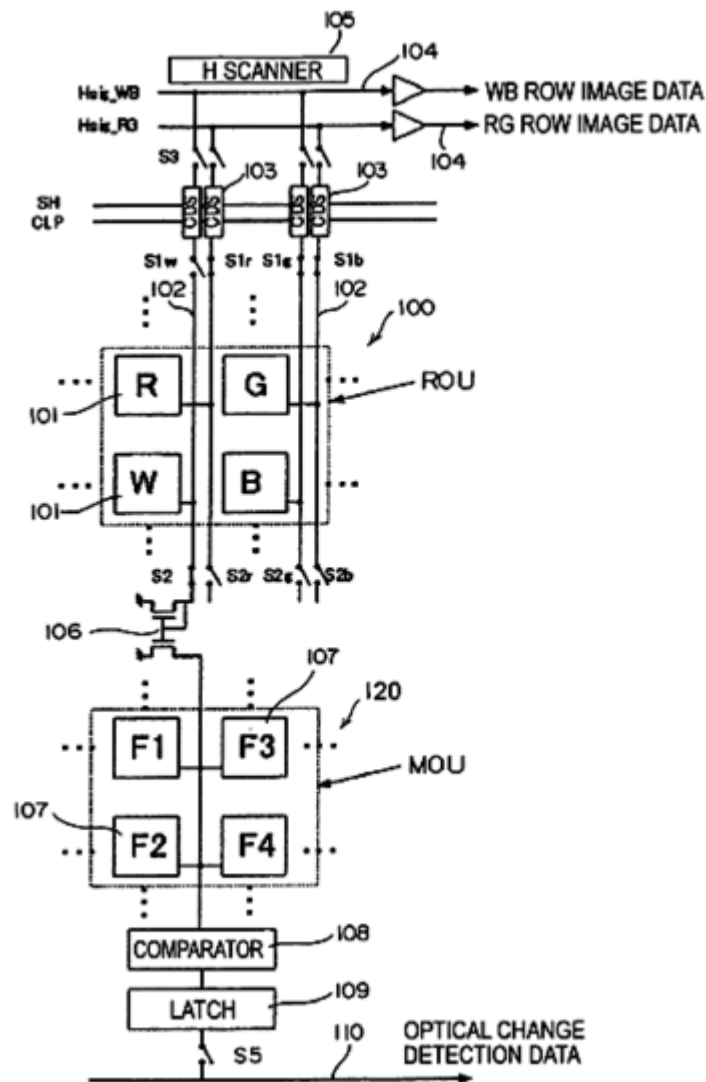
The Foveon X3 sensor uses a different structure such that a pixel utilizes properties of multi-junctions to stack blue, green, and red sensors on top of each other. This arrangement does not require a demosaicing algorithm because each pixel has information about each color. Dick Merrill of Foveon distinguishes the approaches as "vertical color filter" for the Foveon X3 versus "lateral color filter" for the CFA.

### ***List of color filter arrays***

Image	Name	Description	Pattern size (pixels)
	Bayer filter	Very common RGB filter. With one blue, one red, and two green.	2×2
	RGBE filter	Bayer-like with one of the green filters modified to "emerald"; used in a few Sony cameras.	2×2
	CYYM filter	One cyan, two yellow, and one magenta; used in a few cameras of Kodak.	2×2
	CYGM filter	One cyan, one yellow, one green, and one magenta; used in a few cameras.	2×2
	RGBW Bayer	Traditional RGBW similar to Bayer and RGBE patterns.	2×2
	RGBW #1		4×4
	RGBW #2	Three example RGBW filters from Kodak, with 50% white.	
	RGBW #3		2×4

## Bayer CFA

FIG. 1A



A 2005 patent application depicting an arrangement of red, green, blue, and "white" sensor filters referred to there as "RGBW color filters having the Bayer pattern".

The Bayer CFA is named for its inventor, Dr. Bryce E. Bayer from Eastman Kodak. It is realized by application of color filters over the photodiodes used in sensors, cameras, videocameras, and scanners, for creation of the color image.

## RGBW sensor

An RGBW matrix (from Red, Green, Blue, White) is a CFA that includes "white" or transparent filter elements that allow the photodiode to respond to all colors of light; that



is, some cells are "panchromatic", and more of the light is detected, rather than absorbed, compared to the Bayer matrix. Kodak announced several RGBW CFA patterns in 2007, all of which have the property that when the panchromatic cells are ignored, the remaining color filtered cells are arranged such that their data can be processed with a standard Bayer demosaicing algorithm.

### ***CYGM sensor***

A CYGM matrix (Cyan, Yellow, Green, Magenta) is a CFA that uses mostly secondary colors, again to allow more of the incident light to be detected rather than absorbed. Other variants include CMY and CMYW matrices.

### ***Manufacture of the CFA***

Diazonaphthoquinone (DNQ)-novolac photoresist is one material used as the carrier for making color filters from color dyes. There is some interference between the dyes and the ultraviolet light needed to properly expose the polymer, though solutions have been found for this problem. Color photoresists sometimes used include those with chemical monikers CMCR101R, CMCR101G, CMCR101B, CMCR106R, CMCR106G, and CMCR106B.

A few sources discuss other specific chemical substances, attending optical properties, and optimal manufacturing processes of color filter arrays.

For instance, Nakamura said that materials for on-chip color filter arrays fall into two categories: pigment and dye. Pigment based CFAs have become the dominant option because they offer higher heat resistance and light resistance compared to dye based CFAs. In either case, thicknesses ranging up to 1 micrometre are readily available.

Theuwissen says "Previously, the color filter was fabricated on a separate glass plate and glued to the CCD (Ishikawa 1981), but nowadays, all single-chip color cameras are provided with an imager which has a color filter on-chip processed (Dillon, 1978) and not as a hybrid." He provides a bibliography focusing on the number, types, aliasing effects, moire patterns, and spatial frequencies of the absorptive filters.

Some sources indicate that the CFA can be manufactured separately and affixed after the sensor has been manufactured, while other sensors have the CFA manufactured directly on the surface of the imager. Theuwissen makes no mention of the materials utilized in CFA manufacture.

At least one early example of an on-chip design utilized gelatin filters (Aoki et al., 1982). The gelatin is sectionalized, via photolithography, and subsequently dyed. Aoki reveals that a CYWG arrangement was used, with the G filter being an overlap of the Y and C filters.

Filter materials are manufacturer specific. Adams et al. state "Several factors influence the CFA's design. First, the individual CFA filters are usually layers of transmissive (absorptive) organic or pigment dyes. Ensuring that the dyes have the right mechanical properties—such as ease of application, durability, and resistance to humidity and other atmospheric stresses—is a challenging task. This makes it difficult, at best, to fine-tune the spectral responsivities."

Given that the CFAs are deposited on the image sensor surface at the BEOL (back end of line, the later stages of the integrated circuit manufacturing line), where a low-temperature regime must be rigidly observed (due to the low melting temperature of the aluminum metalized "wires" and the substrate mobility of the dopants implanted within the bulk silicon), organics would be preferred over glass. On the other hand, some CVD silicon oxide processes are low temperature processes.

Ocean Optics has indicated that their patented dichroic filter CFA process (alternating thin films of ZnS and Cryolite) can be applied to spectroscopic CCDs. Gersteltec sells photoresists that possesses color filter properties.

### **Some pigment and dye molecules used in CFAs**

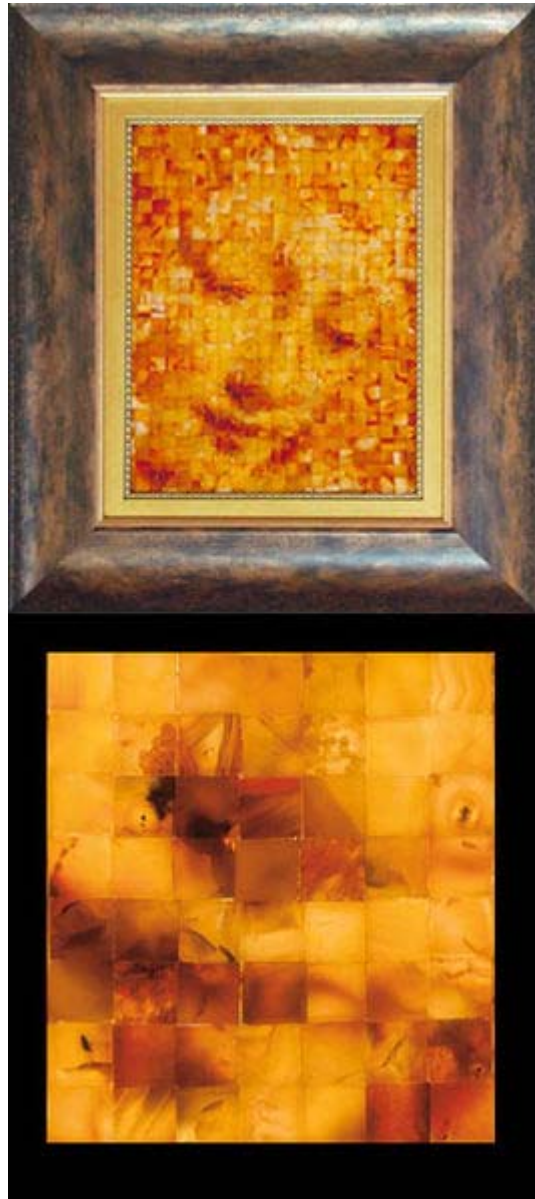
In U.S.P.# 4,808,501, Carl Chiulli cites the use of 5 chemicals, three of which are C.I. #12715, AKA Solvent Red 8; Solvent Yellow 88; and C.I. # 61551, Solvent Blue 36. In U.S.P. # 5,096,801 Koya et. al., of Fuji Phot Film company, list some 150-200 chemical structures, mainly azo dyes and pyrazolone-diazenyl, but fail to provide chemical names, CAS Registry numbers, or Colour Index numbers.

### **Optically efficient CFA implementation**

Nakamura provides a schematic and bibliographic items illustrating the importance of microlenses, their f-number, and the interplay with the CFA and CCD array. Further, a short discussion of anti-reflection films is offered, though Janesick's work appears is more concerned with photon-silicon interaction. Early work on microlenses and on the three-CCD/prism cameras stress the importance of a fully integrated design solution for CFAs. The camera system, as a whole, benefits from careful consideration of CFA technologies and their interplay with other sensor properties.



## Impressionist mosaics



St. Anne in Carnelian, with close up of mouth. Roy Feinson

Unlike traditional mosaics which rely on differently colored material arranged in arbitrary configurations to make an image, impressionist mosaics are created by arranging square, homogenously colored tiles in a grid-like, non-overlapped fashion, using the natural flaws and marbling in the tiles to create the impression of an image.

Using stones that are of relatively uniform color and texture (typically pre-cut natural gemstones such as jasper, marble, or amethyst), the resulting mosaics have a uniquely ethereal quality that distinguishes them from traditional processes. Since the technique uses uniformly cut stones, it does not require grouting. The work shown on the right was created by Roy Feinson using translucent carnelian. This particular impressionist mosaic -- with the image only visible when lit from behind -- is the only known example in existence.

## ***The Process***

Impressionist mosaics are created by taking dozens of measurements of every tile in the artist's "palette". The measurements are obtained by digitally photographing each tile and separating it into a grid of sixteen equal sections and analyzing each section for color, contrast and marbling. The resultant data are stored in a database and operated on by proprietary software, which recommends placements for all the tiles. Since the tiles are generally square, the software considers all four possible rotations for each tile, which greatly increases the odds that a given tile will find a good 'home'. Each tile is equivalent to sixteen pixels in the final mosaic since its final location is a function of sixteen sections. While the software is an important component of this process, the artist must still rely on traditional hand-eye techniques to complete the image.

## ***Differences from Traditional Mosaics***

Traditional mosaics have a history dating back to at least the fourth century BC, and employ a variety of methodologies to create their images. However, traditional mosaics share the common feature of employing small, uniformly colored materials (tesserae) to create a pattern or picture. Because the tiles can be cut into irregular shapes to conform to the base pattern, mosaicists are able to create works of astonishing detail and color.

Alternatively, pixel tile mosaics, such as those found on the floor of the University of Toronto pool, employ standard sized tiles (generally 1 x 1 or 2 by 2 inch) in a variety of colors arranged in a uniform matrix. Each tile is a different color and represents a single 'pixel' in the final image. The resulting mosaic is typically coarse and of very low resolution.

## ***History***

Pioneering work in this field was conducted in the 1990s by California mosaic artist Roy Feinson, who because of its underlying similarities to 19th century impressionism coined the term Impressionist Mosaics.

In 2006, mosaic artists Nick Berg and Alan Roth made custom mosaics using this technique commercially available in marble and wood. Because of the increased image resolution inherent in the impressionist mosaic process, they coined the terms High Definition Mosaics and Photo-realistic Mosaics. Their studio, Exactmosaics, is based in San Francisco, CA.



## Chapter-5

# Components & Applications of Mosaic

### Cosmatesque



Cosmatesque screen at the Basilica di San Giovanni in Laterano. Some works of Deodatus di Cosma for Colonna family are housed in the basilica.

**Cosmatesque style** is a style of geometric decorative inlay stonework typical of Medieval Italy, and especially of Rome and its surroundings. It was used most extensively for the decoration of church floors, but was also used to decorate church walls, pulpits, and bishop's thrones. The name derives from the *Cosmati*, the leading family workshop of marble craftsmen in Rome who created such geometrical



decorations. The style spread across Europe, where it was used in the most prestigious churches; the high altar of Westminster Abbey, for example, is decorated with a cosmatesque marble floor.

### ***Description and early history***



Typical *opus alexandrinum* guilloche floor in Cosmati style from the Cathedral at Terracina.

The Cosmatesque style takes its name from the family of the Cosmati, which flourished in Rome during the twelfth and thirteenth centuries and practiced the art of mosaic. The Cosmati work has this peculiarity, that it is a glass mosaic used in combination with marble. At times it is inlaid on the white marble architraves of doors, on the friezes of cloisters, the flutings of columns, and on sepulchral monuments. Again, it frames panels, of porphyry or other marbles, on pulpits, episcopal chairs, screens, etc., or is itself used as a panel. The color is brilliant, — gold tesserae being freely used. While more frequent in Rome than elsewhere, its use is not confined to that city. Among other places it is found in the Cappella Palatina in Palermo. Just what its connection may be with the southern art of Sicily has yet to be determined.

Although the Cosmati of 12th Century Rome are the eponymous craftsmen of the style, they do not seem to have been the first to develop the art. A similar style may be seen in

the pavement of the Benedictine abbey of Monte Cassino (1066-1071), built using workers from Constantinople, making it likely that the geometric style was heavily influenced by Byzantine floor mosaics. However, the technique is different, because Cosmati floors were made from many different size and shape pieces of stone, a technique quite different from opus tessellatum mosaics where the patterns are made from small units which are all the same size and shape. The stone used by the cosmati artists were salvaged material from the ruins of ancient Roman buildings, the large roundels being the carefully cut cross sections of Roman columns .

According to the Catholic Encyclopedia, this style of inlaid ornamental mosaic was "introduced into the decorative art of Europe during the twelfth century, by a marble-worker named Laurentius [also known as "Lorenzo Cosmati"], a native of Anagni, a small hill-town thirty-seven miles east-south-east of Rome. Laurentius acquired his craft from Greek masters and for a time followed their method of work, but early in his career, freeing himself from Byzantine traditions and influences, he worked along original lines and evolved a new style of decorative mosaic, vigorous in colour and design, which he invariably employed in conjunction with plain or sculptured marble surfaces, making it a decorative accessory to some architectural feature.

"As a rule he used white or light-coloured marbles for his backgrounds; these he inlaid with squares, parallelograms, and circles of darker marble, porphyry, or serpentine, surrounding them with ribbons of mosaic composed of coloured and gold-glass tesserae. These harlequinads he separated one from another with marble mouldings, carvings, and flat bands, and further enriched them with mosaic. His earliest recorded work was executed for a church at Fabieri in 1190, and the earliest existing example is to be seen in the church of Ara Coeli at Rome. It consists of an epistle and gospel ambo, a chair, screen, and pavement.

"In much of his work he was assisted by his son, Jacobus, who was not only a sculptor and mosaic-worker, but also an architect of ability, as witness the architectural alterations carried out by him in the cathedral of Civit  Castellana, a foreshadowing of the Renaissance. This was a work in which other members of his family took part, and they were all followers of the craft for four generations. Those attaining eminence in their art are named in the following genealogical epitome: Laurentius (1140-1210); Jacobus (1165-1234); Luca (1221-1240); Jacobus (1213-1293); Deodatus (1225-1294); Johannes (1231-1303)."



## Terminology



Stanza della Segnatura.

Cosmatesque work is also known as *opus alexandrinum*. Definitions of this term, and the distinction between it and *opus sectile*, vary somewhat. Some restrict *opus alexandrinum* to the typical large designs, especially for floors, using white guilloche patterns filled in with roundels and bands in coloured designs using small pieces. Others include any geometric design including large pieces, as in the picture from Spoleto (right side) below, whereas *opus sectile* also includes figurative designs made in the same technique.

*Opus alexandrinum* is another form of *opus sectile*, where but few colors are used, such as white and black, or dark green on a red ground, or vice versa. This term is particularly employed to designate a species of geometrical mosaic, found in combination with large slabs of marble, much used on the pavements of medieval Roman churches and even in Renaissance times, as, for instance, on the pavements of the Sistine Chapel and the stanza of the Segnatura.

## ***Examples in Rome***

Among the churches decorated in cosmatesque style in Rome, the most noteworthy are San Lorenzo fuori le Mura, San Saba, San Paolo fuori le Mura, Santa Maria in Aracoeli, Santa Maria in Cosmedin, Santa Maria Maggiore and the Stanza della Segnatura at the Vatican. Outside Rome, Anagni and Ferentino contain remarkable cosmatesque works. Also, Cosmati built innovative decoration for the church of Santa Maria di Pozzano at Civita Castellana.

## ***Gallery***



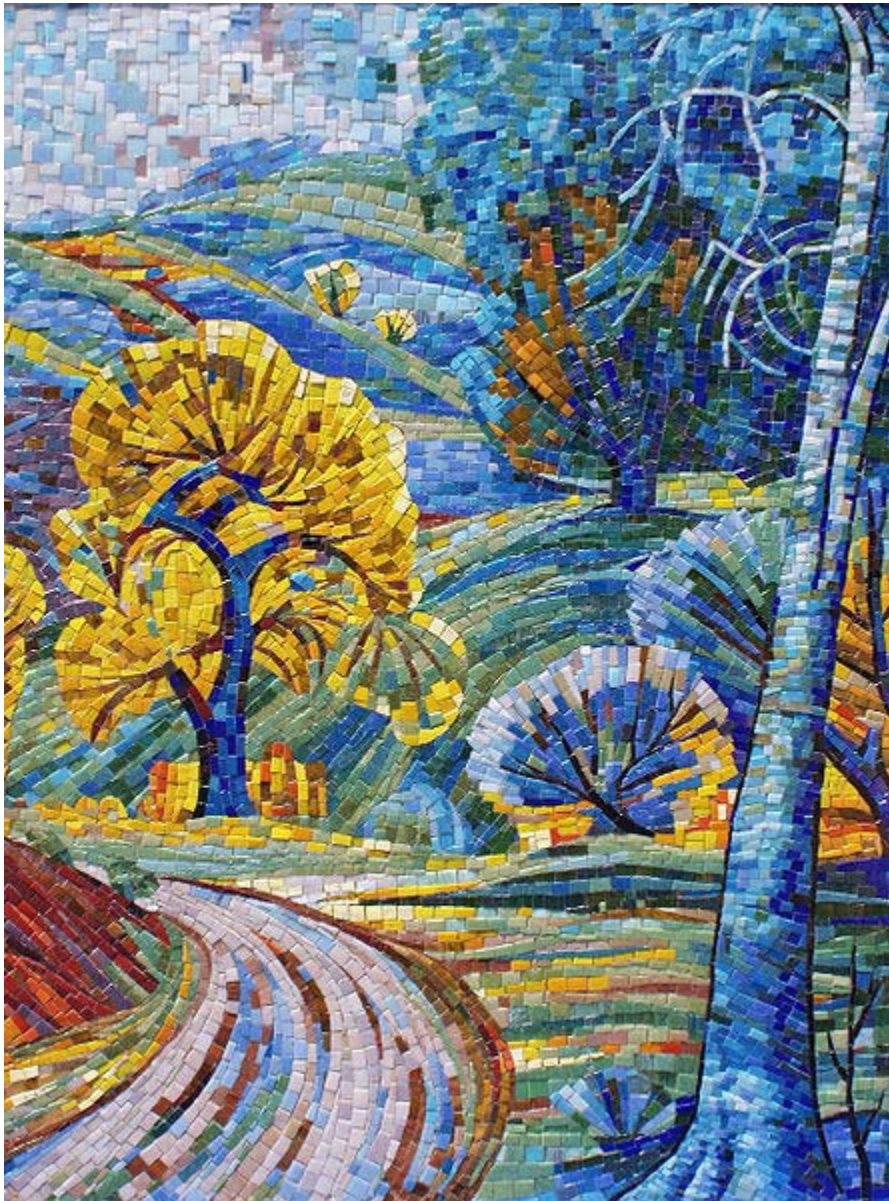
Cosmatesque decoration from the cloisters of San Paolo fuori le Mura, Rome.



Detail of Cosmatesque floor, from the central nave of the Basilica di Santa Maria Maggiore, Rome.



## Glass tiles



Glass mosaic (detail). Glass tiles can be observed.

**Glass tiles** are pieces of glass formed into consistent shapes. Glass was used in mosaics as early as 2500 BC, but it took until the 3rd Century BC before innovative artisans in Greece, Persia and India created glass tiles.



Whereas clay tiles are dated as early as 8,000 BC, there were significant barriers to the development of glass tiles, including the high temperatures required to melt glass, and the complexities of mastering various annealing curves for glass.

In recent years, glass tiles have become popular for both field and accent tiles. This trend can be attributed to recent technological breakthroughs, as well as the tiles' inherent properties, in particular their potential to impart intense color and reflect light, and their imperviousness to water.

Glass tile introduces complexities to the installer. Since glass is more rigid than ceramic or porcelain tile, glass tiles break more readily under the duress of substrate shifts.

*Smalti tile*, sometimes referred to as *Byzantine glass mosaic tile*, are typically opaque glass tiles that were originally developed for use in mosaics created during the time of the Byzantine empire.

Smalti is made by mixing molten glass with metal oxides for color; the result is a cloudy mixture that is poured into flat slabs that are cooled and broken into individual pieces. The molten mixture can also be topped with gold leaf, followed by a thin glass film to protect against tarnishing. During the Byzantine era, Constantinople became the center of the mosaic craft, and the use of gold leaf glass mosaic reached perhaps its greatest artistic expression in the former seat of the Orthodox patriarch of Constantinople, the Hagia Sophia.

Traditional smalti tiles are still found today in many European churches and ornamental objects; the method is also used by some present-day artisans. In the 1920s, mass production methods were applied to Smalti tile manufacturing, which enabled these tiles to find their way into many middle class homes. Instead of the old method of rolling the colored glass mixture out, cooling, and cutting, the new method called for molten liquid to be poured and cooled in trays, usually resulting in 3/4 inch chicklet-type pieces.

Since the 1990s a variety of modern glass tile technologies, including methods to take used glass and recreate it as 'green' tiles, has resulted in a resurgence of interest in glass tile as a floor and wall cladding. It is now commonly used in kitchens, spas, and bathrooms. And while smalti tiles are still popular, small and large format glass products are now commonly formed using cast and fused glass methods. The plasticity of these last two methods has resulted in a wide variety of looks and applications, including floor tiles

In the late 1990s, special glass tiles have been coated on the back side with a receptive white coating. This has allowed impregnation of heat-transfer dyes by a printing process reproducing high resolution pictures and designs. Custom printed glass tile and glass tile murals exhibit the toughness of glass on the wearing surface with photo-like pictures. These are especially practical in kitchens and showers, where cleanser and moisture resistance are important.



A honeycomb is an example of a tessellated natural structure

A **tessellation** or **tiling** of the plane is a collection of plane figures that fills the plane with no overlaps and no gaps. One may also speak of tessellations of parts of the plane or of other surfaces. Generalizations to higher dimensions are also possible. Tessellations frequently appeared in the art of M. C. Escher. Tessellations are seen throughout art history, from ancient architecture to modern art.

In Latin, *tessella* is a small cubical piece of clay, stone or glass used to make mosaics. The word "tessella" means "small square" (from "tessera", square, which in its turn is from the Greek word for "four"). It corresponds with the everyday term *tiling* which refers to applications of tessellations, often made of glazed clay.

### **Wallpaper groups**

Tilings with translational symmetry can be categorized by wallpaper group, of which 17 exist. All seventeen of these groups are represented in the Alhambra palace in Granada, Spain. Of the three regular tilings two are in the category  $p6m$  and one is in  $p4m$ .



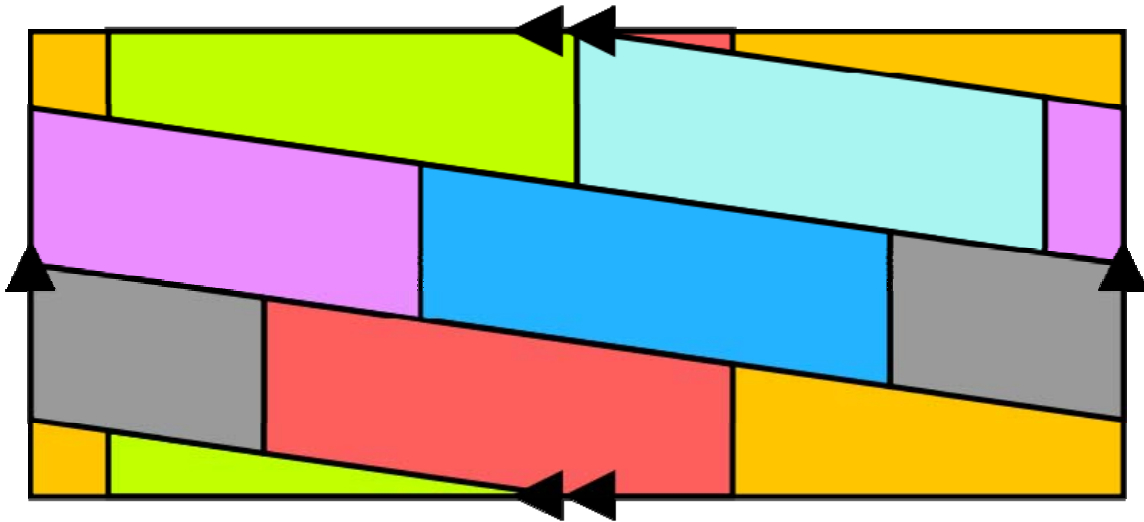
# Tessellation



A tessellation of pavement



## ***Tessellations and color***



If this parallelogram pattern is colored before tiling it over a plane, seven colors are required to ensure each complete parallelogram has a consistent color that is distinct from that of adjacent areas. (This tiling can be compared to the surface of a torus.) Coloring after tiling, only four colors are needed.

When discussing a tiling that is displayed in colors, to avoid ambiguity one needs to specify whether the colors are part of the tiling or just part of its illustration.

The four color theorem states that for every tessellation of a normal Euclidean plane, with a set of four available colors, each tile can be colored in one color such that no tiles of equal color meet at a curve of positive length. Note that the coloring guaranteed by the four-color theorem will not in general respect the symmetries of the tessellation. To produce a coloring which does, as many as seven colors may be needed, as in the picture at right.

## ***Tessellations with quadrilaterals***

Copies of an arbitrary quadrilateral can form a tessellation with 2-fold rotational centers at the midpoints of all sides, and translational symmetry whose basis vectors are the diagonal of the quadrilateral or, equivalently, one of these and the sum or difference of the two. For an asymmetric quadrilateral this tiling belongs to wallpaper group p2. As fundamental domain we have the quadrilateral. Equivalently, we can construct a parallelogram subtended by a minimal set of translation vectors, starting from a rotational center. We can divide this by one diagonal, and take one half (a triangle) as fundamental domain. Such a triangle has the same area as the quadrilateral and can be constructed from it by cutting and pasting.

## ***Regular and semi-regular tessellations***



Hexagonal tessellation of a floor

A **regular tessellation** is a highly symmetric tessellation made up of congruent regular polygons. Only three regular tessellations exist: those made up of equilateral triangles, squares, or hexagons. A **semiregular tessellation** uses a variety of regular polygons; there are eight of these. The arrangement of polygons at every vertex point is identical. An **edge-to-edge tessellation** is even less regular: the only requirement is that adjacent tiles only share full sides, i.e. no tile shares a partial side with any other tile. Other types of tessellations exist, depending on types of figures and types of pattern. There are regular versus irregular, periodic versus aperiodic, symmetric versus asymmetric, and fractal tessellations, as well as other classifications.

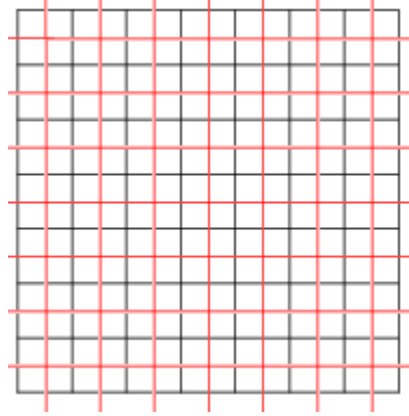
Penrose tilings using two different polygons are the most famous example of tessellations that create aperiodic patterns. They belong to a general class of aperiodic tilings that can be constructed out of self-replicating sets of polygons by using recursion.

A *monohedral tiling* is a tessellation in which all tiles are congruent. Spiral monohedral tilings include the Voderberg tiling discovered by Hans Voderberg in 1936, whose unit tile is a nonconvex enneagon; and the Hirschhorn tiling discovered by Michael Hirschhorn in the 1970s, whose unit tile is an irregular pentagon.

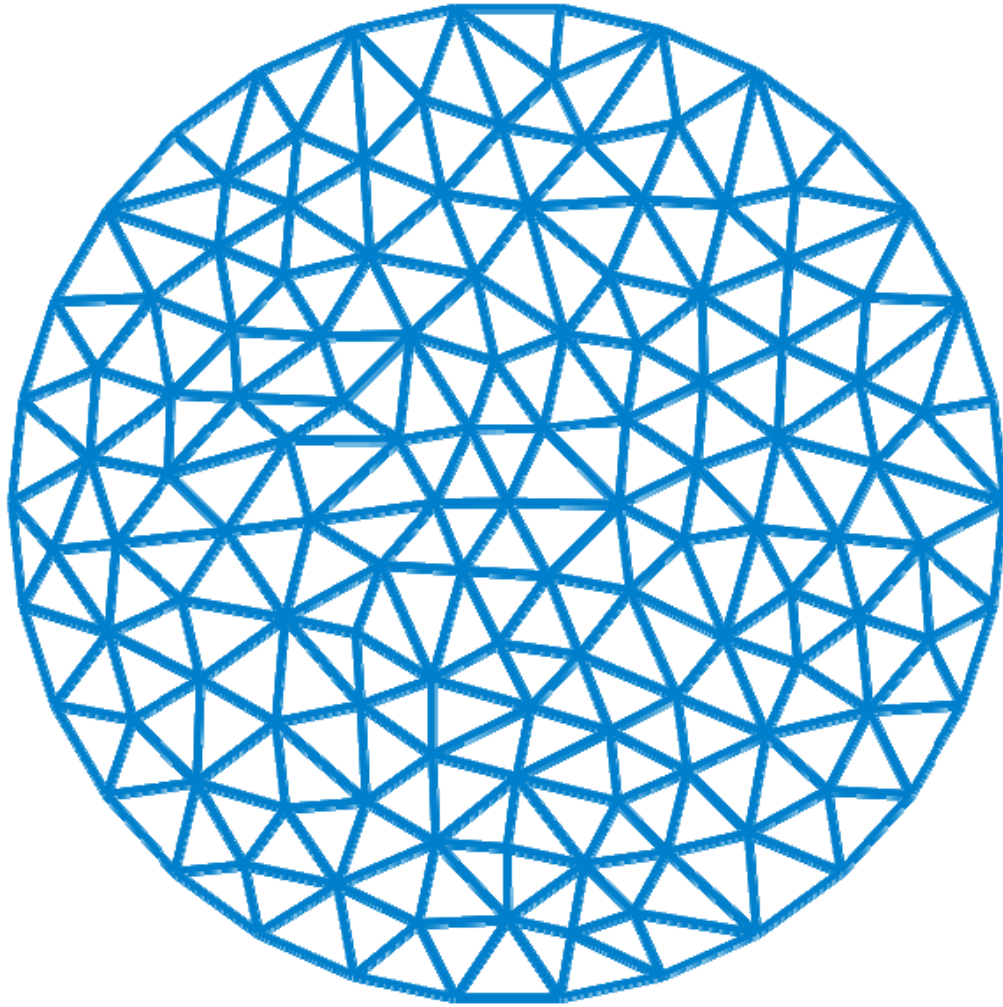


## ***Self-dual tessellations***

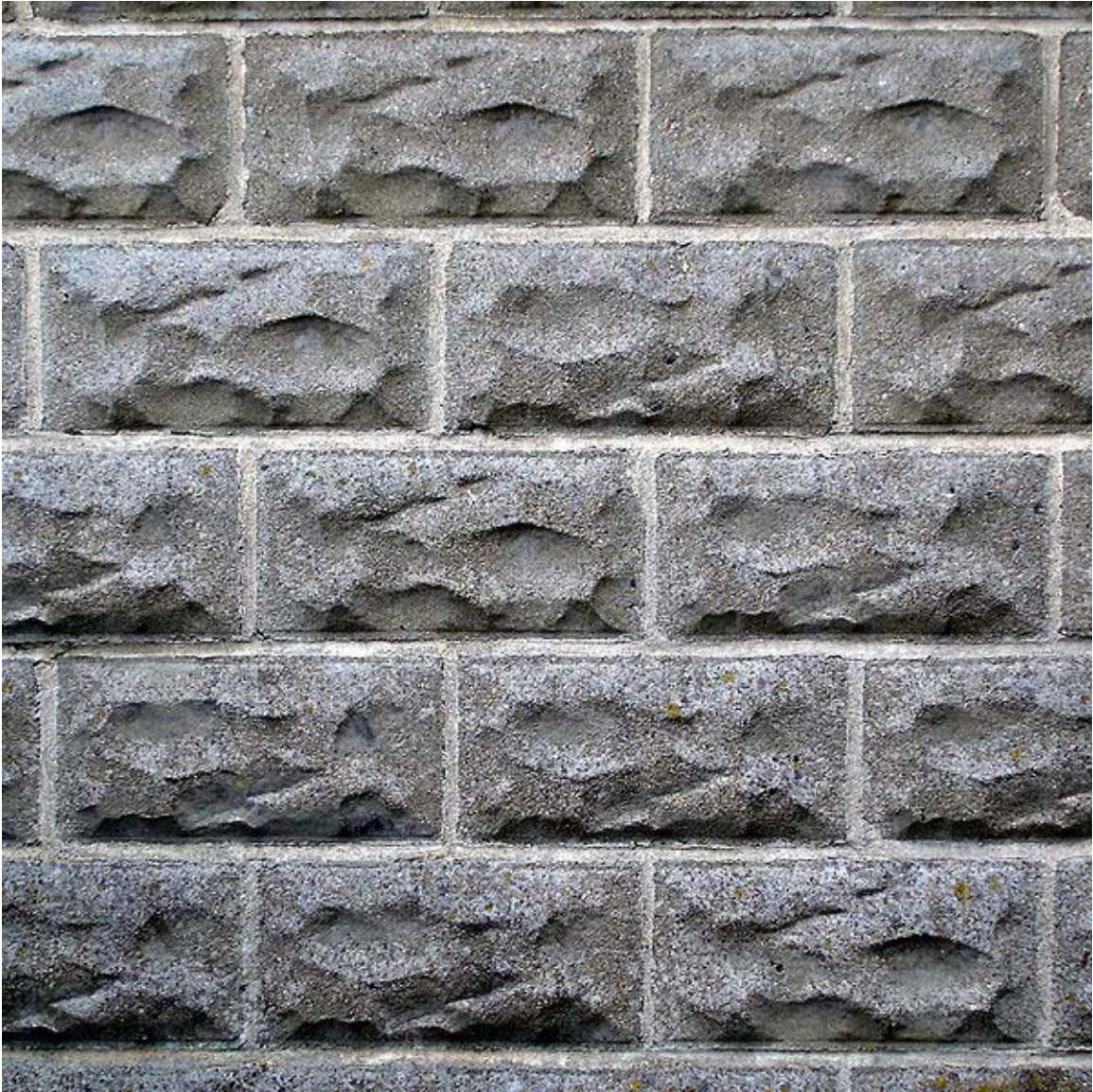
Tilings and honeycombs can also be self-dual. All  $n$ -dimensional hypercubic honeycombs with Schläfli symbols  $\{4, 3^{n-2}, 4\}$ , are self-dual.



## ***Tessellations and computer models***



A tessellation of a disk used to solve a finite element problem.



These rectangular bricks are connected in a tessellation which, considered as an edge-to-edge tiling, is topologically identical to a hexagonal tiling; each hexagon is flattened into a rectangle whose long edges are divided in two by the neighboring bricks.





This *basketweave* tiling is topologically identical to the Cairo pentagonal tiling, with one side of each rectangle counted as two edges, divided by a vertex on the two neighboring rectangles.

In the subject of computer graphics, tessellation techniques are often used to manage datasets of polygons and divide them into suitable structures for rendering. Normally, at least for real-time rendering, the data is tessellated into triangles, which is sometimes referred to as triangulation. Tessellation is a staple feature of DirectX 11 and OpenGL.

In computer-aided design the constructed design is represented by a boundary representation topological model, where analytical 3D surfaces and curves, limited to faces and edges constitute a continuous boundary of a 3D body. Arbitrary 3D bodies are often too complicated to analyze directly. So they are approximated (tessellated) with a

mesh of small, easy-to-analyze pieces of 3D volume — usually either irregular tetrahedrons, or irregular hexahedrons. The mesh is used for finite element analysis.

Mesh of a surface is usually generated per individual faces and edges (approximated to polylines) so that original limit vertices are included into mesh. To ensure approximation of the original surface suits needs of the further processing 3 basic parameters are usually defined for the surface mesh generator:

- Maximum allowed distance between planar approximation polygon and the surface (aka "sag"). This parameter ensures that mesh is similar enough to the original analytical surface (or the polyline is similar to the original curve).
- Maximum allowed size of the approximation polygon (for triangulations it can be maximum allowed length of triangle sides). This parameter ensures enough detail for further analysis.
- Maximum allowed angle between two adjacent approximation polygons (on the same face). This parameter ensures that even very small humps or hollows that can have significant effect to analysis will not disappear in mesh.

Algorithm generating mesh is driven by the parameters (example: CATIA V5 tessellation library). Some computer analyses require adaptive mesh. Mesh is being locally enhanced (using stronger parameters) in areas where it is needed during the analysis.

Some geodesic domes are designed by tessellating the sphere with triangles that are as close to equilateral triangles as possible.

### ***Tessellations in nature***

Basaltic lava flows often display columnar jointing as a result of contraction forces causing cracks as the lava cools. The extensive crack networks that develop often produce hexagonal columns of lava. One example of such an array of columns is the Giant's Causeway in Northern Ireland.

The Tessellated pavement in Tasmania is a rare sedimentary rock formation where the rock has fractured into rectangular blocks.

### ***Number of sides of a polygon versus number of sides at a vertex***

For an infinite tiling, let  $a$  be the average number of sides of a polygon, and  $b$  the average number of sides meeting at a vertex. Then  $(a - 2)(b - 2) = 4$ . For example, we have the combinations  $(3, 6)$ ,  $(3\frac{1}{2}, 5)$ ,  $(3\frac{3}{4}, 4\frac{2}{3})$ ,  $(4, 4)$ ,  $(6, 3)$ , for the tilings in the article Tilings of regular polygons.

A continuation of a side in a straight line beyond a vertex is counted as a separate side. For example, the bricks in the picture are considered hexagons, and we have combination

(6, 3). Similarly, for the basketweave tiling often found on bathroom floors, we have  $(5, 3\frac{1}{2})$ .

For a tiling which repeats itself, one can take the averages over the repeating part. In the general case the averages are taken as the limits for a region expanding to the whole plane. In cases like an infinite row of tiles, or tiles getting smaller and smaller outwardly, the outside is not negligible and should also be counted as a tile while taking the limit. In extreme cases the limits may not exist, or depend on how the region is expanded to infinity.

For finite tessellations and polyhedra we have

$$(a - 2)(b - 2) = 4 \left(1 - \frac{\chi}{F}\right) \left(1 - \frac{\chi}{V}\right)$$

where  $F$  is the number of faces and  $V$  the number of vertices, and  $\chi$  is the Euler characteristic (for the plane and for a polyhedron without holes: 2), and, again, in the plane the outside counts as a face.

The formula follows observing that the number of sides of a face, summed over all faces, gives twice the total number of sides in the entire tessellation, which can be expressed in terms of the number of faces and the number of vertices. Similarly the number of sides at a vertex, summed over all vertices, also gives twice the total number of sides. From the two results the formula readily follows.

In most cases the number of sides of a face is the same as the number of vertices of a face, and the number of sides meeting at a vertex is the same as the number of faces meeting at a vertex. However, in a case like two square faces touching at a corner, the number of sides of the outer face is 8, so if the number of vertices is counted the common corner has to be counted twice. Similarly the number of sides meeting at that corner is 4, so if the number of faces at that corner is counted the face meeting the corner twice has to be counted twice.

A tile with a hole, filled with one or more other tiles, is not permissible, because the network of all sides inside and outside is disconnected. However it is allowed with a cut so that the tile with the hole touches itself. For counting the number of sides of this tile, the cut should be counted twice.

For the Platonic solids we get round numbers, because we take the average over equal numbers: for  $(a - 2)(b - 2)$  we get 1, 2, and 3.

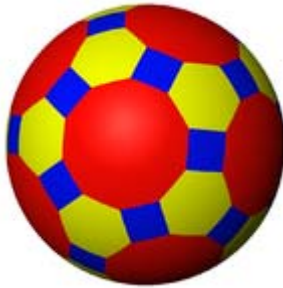
From the formula for a finite polyhedron we see that in the case that while expanding to an infinite polyhedron the number of holes (each contributing  $-2$  to the Euler characteristic) grows proportionally with the number of faces and the number of vertices, the limit of  $(a - 2)(b - 2)$  is larger than 4. For example, consider one layer of cubes, extending in two directions, with one of every  $2 \times 2$  cubes removed. This has



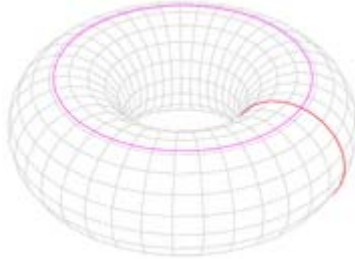
combination (4, 5), with  $(a - 2)(b - 2) = 6 = 4(1 + 2 / 10)(1 + 2 / 8)$ , corresponding to having 10 faces and 8 vertices per hole.

Note that the result does not depend on the edges being line segments and the faces being parts of planes: mathematical rigor to deal with pathological cases aside, they can also be curves and curved surfaces.

## Tessellations of other spaces



An example tessellation of the surface of a sphere by a truncated icosidodecahedron.



A torus can be tiled by a repeating matrix of isogonal quadrilaterals.



M.C. Escher, *Circle Limit III* (1959)

As well as tessellating the 2-dimensional Euclidean plane, it is also possible to tessellate other  $n$ -dimensional spaces by filling them with  $n$ -dimensional polytopes. Tessellations of other spaces are often referred to as honeycombs. Examples of tessellations of other spaces include:

- Tessellations of  $n$ -dimensional Euclidean space. For example, filling 3-dimensional Euclidean space with cubes to create a cubic honeycomb.
- Tessellations of  $n$ -dimensional elliptic space, either the  $n$ -sphere (spherical tiling, spherical polyhedron) or  $n$ -dimensional real projective space (elliptic tiling, projective polyhedron).

For example, projecting the edges of a regular dodecahedron onto its circumsphere creates a tessellation of the 2-dimensional sphere with regular spherical pentagons, while taking the quotient by the antipodal map yields the hemi-dodecahedron, a tiling of the projective plane.

- Tessellations of  $n$ -dimensional hyperbolic space. For example, M. C. Escher's *Circle Limit III* depicts a tessellation of the hyperbolic plane using the Poincaré disk model with congruent fish-like shapes. The hyperbolic plane admits a tessellation with regular  $p$ -gons meeting in  $q$ 's whenever  $\frac{1}{p} + \frac{1}{q} < \frac{1}{2}$ ; *Circle Limit III* may be understood as a tiling of octagons meeting in threes, with all sides replaced with jagged lines and each octagon then cut into four fish.

There are also abstract polyhedra which do not correspond to a tessellation of a manifold because they are not locally spherical (locally Euclidean, like a manifold), such as the 11-cell and the 57-cell. These can be seen as tilings of more general spaces.

## Zellige



Zellige used for a fountain

**Zellige**, **Zillij** or **Zellij** (Arabic: الزليج) is terra cotta tilework covered with enamel in the form of chips set into plaster. It is one of the main characteristics of the Moroccan architecture though it's also used in other North African and Muslim countries. It consists of geometrical mosaics made ceramic used mainly as an ornament for walls, ceilings, fountains, floors, pools, tables, etc.

### ***History***

The art of Zellige flourished at the Hispano-Moresque period (Azulejo). It then appeared in Morocco in the 10th century using nuances of white and brown colours.

The art remained very limited in use until the Merinid dynasty who gave it more importance around the 14th century. Blue, red, green and yellow colours were introduced in the 17th century. The old enamels with the natural colours were used until the beginning of the 20th century and the colors had probably not evolved much since the period of Merinids. The cities of Fes and Meknes remain the centers of this art.

Patrons of the art used Zellige historically to decorate their homes as a statement of luxury and the sophistication of the inhabitants. Zellige is typically a series of patterns utilizing colorful geometric shapes. This framework of expression arose from the need of Islamic artists to create spatial decorations that avoided depictions of living things, consistent with the teachings of Islamic law.

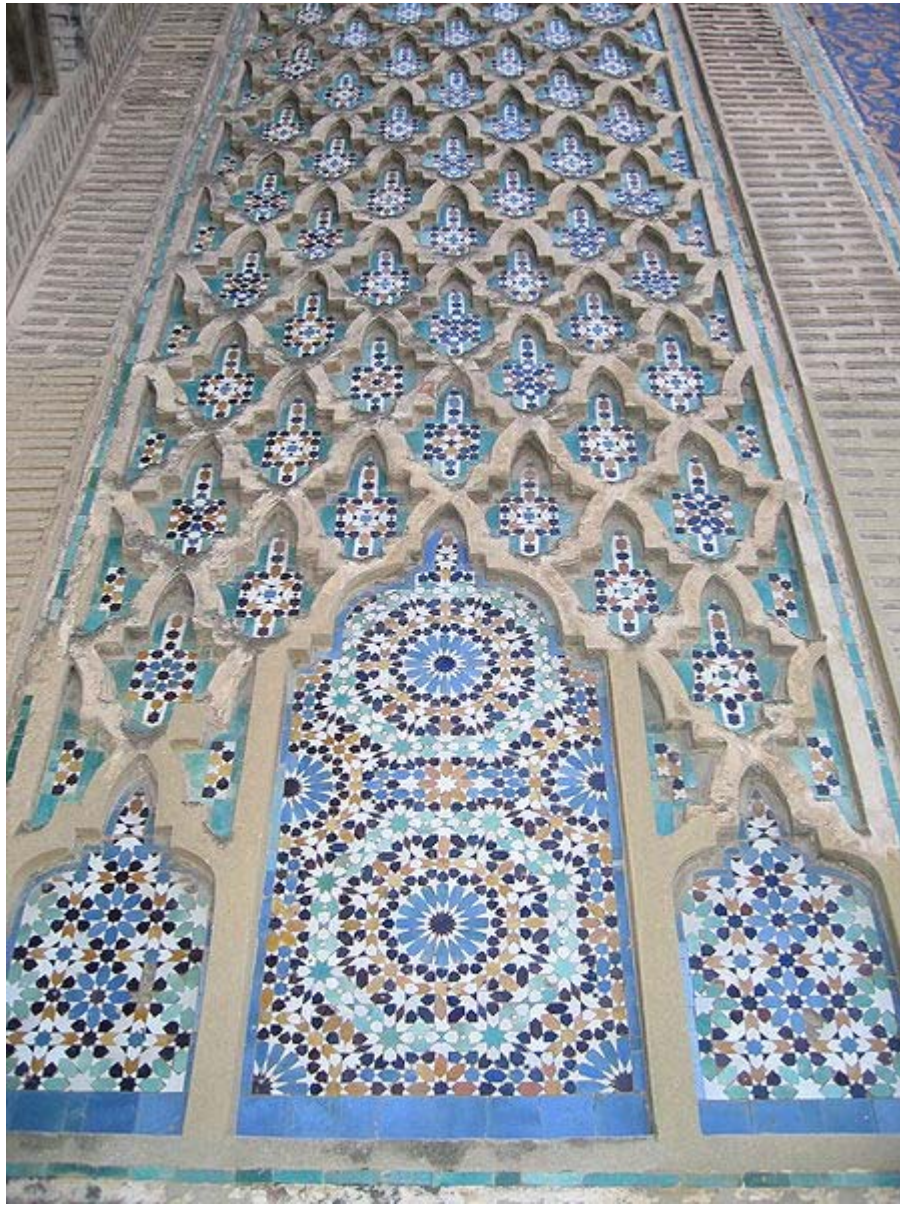
### **Forms and trends**

The pallet of the colors of the zellige started to grow rich by colors which make it possible to multiply the compositions *ad infinitum* (see picture above). The most current form of the zellige is the square one whose dimensions are variable. Other forms are also possible in composition: the Octagonal combined with a cabochon, a star, a cross, etc. It is then molded with a thickness of approximately 2 centimeters. There exists in simple squares of 10 per 10 centimeters or with the corners cut to be combined with a coloured cabochon. To pave the grounds Bejmat, a paving stone of 15 per 5 centimeters approximately and 2 centimeters thick, can also be used.

Themes often employ Kufic script, as it very nicely fits with the geometry of the mosaic tiles, and patterns often culminate centrally in the Rub El Hizb. The patterns evinced in the mosaics is currently of interest in academic research in mathematics. Considerable research into modelling of these patterns has taken place.







## **Zellige craftsmanship**

Zellige making is considered an art in itself. The art is transmitted from generation to generation by *maâlems* (master craftsmen). A long training starts at childhood in order to master exceptional skills.

Assiduous attention to detail is very important in the process of creating Zellige works. The small shaped (cut according to a precise radius gauge), painted and enamel covered squares are then assembled together in a geometrical structure as in puzzle to form the final single piece. The process has not varied for one millennium though conception and design has started using new technologies such as data processing.